HLB

TP 14077E

Boarding Small Regional Aircraft

Prepared for:
Transportation Development Centre Transport Canada

by:

HLB Decision Economics Inc.

in association with

Rutenberg Design

April 2003

HLB DECISION ECONOMICS INC.

RISK ANALYSIS · INVESTMENT AND FINANCE
ECONOMICS AND POLICY

103-07584/

TP 14077E

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Un sommaire français se trouve avant la table des matières.

Transport Canada / Transports Canada

PUBLICATION DATA FORM

1. Transport Canada Publication No.	2. Project No.	3. Recipient's Catalogue No.
TP 14077E	9802	

4. Title and Subtitle	5. Publication Date
Boarding Small Regional Aircraft	April 2003
	6. Performing Organization Document No.

7. Author(s)	8. Transport Canada File No.
D. Lewis, B. Falkenhagen, E. Tomaszewska, and U. Rutenberg	ZCD2450-103-144

9. Performing Organization Name and Address		10. PWGSC File No.
HLB Decision Economics Inc. 1525 Carling Avenue, Suite 500 Ottawa, Ontario Canada K1Z 8R9	Rutenberg Design 27 Sable Run Drive Stittsville, Ontario Canada K2S 1W8	XSD-9-01888
		11. PWGSC or Transport Canada Contract No.
		T8200-9-9570/001/XSD

12. Sponsoring Agency Name and Address	13. Type of Publication and Period Covered
Transportation Development Centre (TDC) 800 René Lévesque Blvd. West Suite 600 Montreal, Quebec H3B 1X9	Final
	14. Project Officer
	B. Jamieson Smith

15. Supplementary Notes (Funding programs, titles of related publications, etc.)

16. Abstract

This study examined the accessibility of small passenger aircraft (defined as aircraft with 19 to 60 passenger seats) used in scheduled air travel in Canada today to passengers using a wheelchair. Information was collected and analyzed in relation to the types and availability of boarding devices in Canadian airports, their use, cost, and operational characteristics – in particular, compatibility with small aircraft – as well as their performance and effectiveness in terms of such things as comfort for the passenger and integration with the general boarding.

Key findings included the following:

- All airports surveyed have at least a boarding chair and many have a mechanical lift, but none have ramps or low-level boarding bridges.
- Most of the identified equipment is compatible with most small aircraft types; however, certain incompatibilities do exist.
- Forty-six percent of airports serve an aircraft type for which the airport has no compatible combination of level change and boarding or transfer chair.

Recommendations:

- Provide full passenger information to facilitate passenger choice and promote provider competition.
- Develop an innovative financing solution based on the public-private partnership model to ensure low-level boarding bridges at all airports where such a solution is architecturally feasible.
- Ensure public-private co-operation to finance and steer development of accessible small aircraft interior layouts.

17. Key Words	18. Distribution Statement
Small aircraft, boarding equipment, boarding procedures, aircraft accessibility, seat accessibility, aisle accessibility, boarding chair, transfer chair, disembarkation	Limited number of copies available from the Transportation Development Centre

19. Security Classification (of this publication)	20. Security Classification (of this page)	21. Declassification (date)	22. No. of Pages	23. Price
Unclassified	Unclassified	—	lxvi, 126, apps	Shipping/ Handling

Transports Canada / Transport Canada

FORMULE DE DONNÉES POUR PUBLICATION

1. N° de la publication de Transports Canada	2. N° de l'étude	3. N° de catalogue du destinataire
TP 14077E	9802	

4. Titre et sous-titre	5. Date de la publication
Boarding Small Regional Aircraft	Avril 2003
	6. N° de document de l'organisme exécutant

7. Auteur(s)	8. N° de dossier - Transports Canada
D. Lewis, B. Falkenhagen, E. Tomaszewska et U. Rutenberg	ZCD2450-103-144

9. Nom et adresse de l'organisme exécutant		10. N° de dossier - TPSGC
HLB Decision Economics Inc. 1525 Carling Avenue, Suite 500 Ottawa (Ontario) Canada K1Z 8R9	Rutenberg Design 27 Sable Run Drive Stittsville (Ontario) Canada K2S 1W8	XSD-9-01888
		11. N° de contrat - TPSGC ou Transports Canada
		T8200-9-9570/001/XSD

12. Nom et adresse de l'organisme parrain	13. Genre de publication et période visée
Centre de développement des transports (CDT) 800, boul. René-Lévesque Ouest Bureau 600 Montréal (Québec) H3B 1X9	Final
	14. Agent de projet
	B. Jamieson Smith

15. Remarques additionnelles (programmes de financement, titres de publications connexes, etc.)

16. Résumé

La présente étude porte sur l'accessibilité aux passagers en fauteuil roulant des petits avions passagers (ou, par définition, des avions de 19 à 60 places) présentement utilisés dans le transport aérien à horaire fixe au Canada. Les chercheurs ont colligé et analysé l'information touchant les types d'équipements d'embarquement dont disposent les aéroports canadiens, leur utilisation réelle, leur coût et leurs caractéristiques d'exploitation – notamment leur compatibilité avec les petits avions – ainsi que leurs performances et leur efficacité, sous l'angle du confort du passager handicapé et de la possibilité pour celui-ci de monter à bord en même temps que les autres passagers.

Voici les principales conclusions tirées de l'étude :

- Tous les aéroports recensés disposent d'au moins un fauteuil d'embarquement. Beaucoup sont munis d'une plate-forme élévatrice, mais aucun n'est doté d'une rampe d'accès ou d'une passerelle d'embarquement niveau sol.
- À quelques exceptions près, les équipements sont compatibles avec la plupart des types de petits avions.
- Quarante-six pour cent des aéroports sont desservis par au moins un type d'appareil pour lequel ils ne possèdent pas la combinaison compatible d'équipement de transfert vertical et de fauteuil d'embarquement ou de transfert.

Recommandations :

- Fournir aux passagers toute l'information dont ils ont besoin pour faire les meilleurs choix et favoriser ainsi la concurrence entre fournisseurs.
- Élaborer une formule de financement novatrice, fondée sur un partenariat public-privé, afin d'installer une passerelle d'embarquement niveau sol à tous les aéroports où une telle installation est possible du point de vue architectural.
- Faire appel à la coopération des secteurs public et privé pour financer et entreprendre l'aménagement de l'intérieur des petits avions de façon à en accroître l'accessibilité.

17. Mots clés	18. Diffusion
Petit avion, équipement d'embarquement, procédures d'embarquement, accès à l'avion, accès au siège, accès au couloir, fauteuil d'embarquement, fauteuil de transfert, débarquement	Le Centre de développement des transports dispose d'un nombre limité d'exemplaires.

19. Classification de sécurité (de cette publication)	20. Classification de sécurité (de cette page)	21. Déclassification (date)	22. Nombre de pages	23. Prix
Non classifiée	Non classifiée	—	lxvi, 126, ann.	Port et manutention

ACKNOWLEDGEMENTS

The authors of the report would like to thank all manufacturers of boarding equipment, airport managers, and airlines who responded to our survey and filled out the questionnaire. Comments from the Canadian Transportation Agency and Transportation Development Centre on the draft version of this report are also gratefully acknowledged.

EXECUTIVE SUMMARY

This study examined boarding equipment and procedures available to persons with a disability on small passenger aircraft (19 to 60 passenger seats) in scheduled service at Canadian airports. Information was collected and analyzed in relation to the availability of boarding devices, their use, cost, performance, and compatibility with small aircraft

The study was built on the following major components:

1. Review of current regulatory environment in relation to small aircraft in Canada and the United States;
2. Analysis of the OAG (Official Airline Guide) data on flight schedules for aircraft size of 19 to 60 passenger seats (for a specific selected period of time);
3. Evaluation of the availability and suitability of "level-change" equipment to access small aircraft, boarding and transfer chairs, and boarding procedures used to board passengers with mobility impairments, including:
   - Survey of equipment manufacturers on devices manufactured, their operational characteristics and compatibility with aircraft,
   - Survey of airports on availability, usage, and performance of equipment,
   - Survey of air carriers on ownership, usage, and performance of equipment;
4. Workshop with stakeholders on survey results and effectiveness of boarding devices;
5. Identification and evaluation of boarding and transfer chairs;
6. Analysis of passenger cabin layout of selected aircraft types most commonly used in scheduled service in Canada;
7. Live boarding and disembarkation demonstrations on selected aircraft types most commonly used in scheduled service in Canada.

The project was carried out in two phases:

- Phase I (from April 2000 to October 2001) included a review of the regulatory environment, collection and analysis of the OAG database on small aircraft use in Canada, a survey of manufacturers, airports and air carriers, an analysis of survey information, and a workshop with stakeholders.
- Phase II or extension of the main phase (from February 2002 to December 2002) included an update on the pattern of small aircraft use in Canada, an analysis of interior cabin layout and access of selected aircraft types, and actual boarding demonstrations.

USE OF SMALL AIRCRAFT IN CANADA AND AIRCRAFT SELECTED FOR DETAILED STUDY

Table 1 gives a list of small aircraft used in Canada in early 2002.

Table 1: Small Aircraft Used in Canada Ranked by Number of Departures

RANK*	AIRCRAFT NAME	SEATS	PERCENTAGE OF FLIGHTS	CUMULATIVE PERCENTAGE OF FLIGHTS
1	De Havilland DHC-8 Dash 8-100	37	30.87	30.87
2	Beechcraft 1900D	19	11.52	42.39
3	De Havilland DHC-8 Dash 8-300	50	11.34	53.74
4	Canadair Regional Jet	50	10.35	64.09
5**	De Havilland DHC8 Dash 8 (100 and 300)	37-50	7.07	71.15
6	Saab SF 340	34	4.95	76.10
7	De Havilland DHC-6 Twin Otter	19	4.86	80.96
8	Fairchild Metroliner	19	4.59	85.55
9	Shorts 360	33	2.57	88.12
10	Embraer RJ 135 /140 /145	37-50	2.52	90.64

Table 1 (continued)

RANK*	AIRCRAFT NAME	SEATS	PERCENTAGE OF FLIGHTS	CUMULATIVE PERCENTAGE OF FLIGHTS
11	BAe (HS) 748	37-46	1.62	92.26
12	Embraer RJ135	37	1.49	93.74
13	Beechcraft all Series	19	1.40	95.14
14	BAe Jetstream 31	19	1.26	96.40
15	Fairchild Dornier 328	29	0.81	97.21
16	ATR all Series	37-50	0.63	97.84
17	Fairchild Dornier 328 Jet	32	0.63	98.47
18	Boeing 727 (Mixed Configuration)	19	0.59	99.05
19	Embraer EMB-120 Brasilia	30	0.54	99.59
20	Douglas DC3 /C-47 Dakota (Passenger)	27	0.18	99.77
21	Embraer RJ140	50	0.18	99.95
22	ATR 42	37	0.05	100.00

NOTES TO TABLE 1:

*Aircraft are ranked according to the level of activity, i.e. the percentage of flights flown on that aircraft. A ranking could also have been made on the basis of passenger trips but these data were not available.

**De Havilland DHC-8 Dash 8 (100 and 300) includes both Dash 8-100 and Dash 8-300. This entry refers to those flights for which OAG did not have precise information on the aircraft type (i.e. Dash 8-100 or Dash 8-300).

SOURCE: Official Airline Guide (OAG), data sample for period from February 4, 2002, to February 10, 2002.

Table 1 demonstrates that 7 of 21 aircraft types (De Havilland DHC-8 Dash 8-100, De Havilland DHC-8 Dash 8-300, Beechcraft 1900D, Canadair Regional Jet, Saab SF 340, De Havilland DHC-6 Twin Otter, and Fairchild Metroliner) account for over 85 percent of flight volume. The remaining 14 types account for 15 percent of flight volume.

CARRIERS OFFERING SERVICES ON SMALL AIRCRAFT

Table 2 lists air carriers using small aircraft for their scheduled services in Canada in early 2002.

Table 2: Air Carriers Using Small Aircraft in Canada

RANK	AIR CARRIER	PERCENTAGE OF FLIGHTS	CUMULATIVE PERCENTAGE OF FLIGHTS
1	Air Canada	62.29	62.29
2	Bearskin Airlines	4.28	66.56
3	Delta Air Lines	3.29	69.85
4	Pacific Coastal Airlines Limited	3.11	72.95
5	Labrador Airways	2.97	75.92
6	Continental Airlines	2.93	78.85
7	First Air	2.79	81.64
8	Provincial Airlines	2.66	84.29
9	Air Creebec (1994) Inc.	2.48	86.77
10	Alaska Airlines	2.43	89.20
11	US Airways	1.94	91.13
12	Aklak Air	1.35	92.48
13	American Airlines	1.17	93.65
14	Harbour Air Ltd	1.08	94.73
15	Northwest Airlines	0.81	95.54
16	Hawkair	0.72	96.26
17	Northwestern Air Lease Ltd.	0.63	96.89
18	United Airlines	0.54	97.43
19	Air North	0.45	97.88
20	Calm Air Intl Ltd	0.45	98.33
21	Transwest Air	0.41	98.74

Table 2 (continued)

RANK	AIR CARRIER	PERCENTAGE OF FLIGHTS	CUMULATIVE PERCENTAGE OF FLIGHTS
22	Skyward Aviation Ltd	0.36	99.10
23	America West Airlines	0.27	99.37
24	Pem-Air	0.23	99.59
25	Buffalo Airways Ltd.	0.18	99.77
26	Midwest Express Airlines Inc.	0.18	99.95
27	Air Saint-Pierre	0.05	100.00

SOURCE: Official Airline Guide (OAG), data sample for period from February 4, 2002, to February 10, 2002.

Table 2 shows that there were 27 airlines providing scheduled services on small aircraft in Canada. The largest carrier was Air Canada. This airline accounted for over 62 percent of all flights. Bearskin Airlines was the second largest, accounting for about 4 percent of flight volume.

A few airlines shown in Table 2 are American-based air carriers. These carriers serve cross-border routes between Canada and the US.

AIRCRAFT TYPES SELECTED FOR A MORE DETAILED STUDY

Table 3 shows the five largest Canadian air carriers together with the small aircraft types used in February 2002.

Table 3: Largest Canadian Air Carriers and Their Fleet Composition

AIRCRAFT/AIR CARRIER	Air Canada	Bearskin Airlines	Pacific Coastal Airlines	Labrador Airways	First Air
De Havilland DHC-8 Dash 8 100	X				X
Beechcraft 1900D	X		X	X	X
De Havilland DHC-8 Dash 8 300	X				X
Canadair Regional Jet	X				
Saab SF 340	X				
De Havilland DHC-6 Twin Otter				X	
Fairchild Metroliner		X			
Shorts 360			X		
BAe (HS) 748	X				X
Boeing 727					X

Table 3 provided an initial list of aircraft types for a further more detailed study. This set had to be further narrowed down to aircraft types that were accessible for inspection in the Ottawa, Dorval, or Toronto airports. As a result, the following aircraft were selected for further detailed study, including live boarding demonstrations:

- Dash 8-100;
- Dash 8-300;
- Beechcraft 1900D;
- Canadair Regional Jet;
- Metroliner;

- HS 748.

In addition, ATR 42 was also added to this list since one of the air carriers indicated that they are purchasing a number of new aircraft of this type.

The aircraft types selected for a detailed study account for over 77 percent of the flight volume (by departure) on small aircraft.

TRENDS IN THE USE OF SMALL AIRCRAFT BY CANADIAN CARRIERS

Interviews with air carriers revealed the following trends in the use of various aircraft types:

1. Air Canada is completely retiring its fleet of the Fokker 28 aircraft series in September 2002.
2. Air Canada is phasing out its fleet of six Beechcraft 1900 aircraft and giving them to Georgian Airlines in September 2002. Air Canada will no longer fly this aircraft on its routes. Georgian Airlines is under contract for Air Canada and will provide regional services, operating out of Pearson Airport. Georgian Airlines is currently flying a substantial fleet of Beechcraft 1900 aircraft.
3. In the future Regional Jets, new Dash 8s or ATR 42s will replace the aging Dash 8 series.
4. First Air has ordered several new ATR 42s for its services.

BOARDING DEVICES FOR SMALL AIRCRAFT, THEIR OPERATIONAL CHARACTERISTICS AND EFFECTIVENESS

The surveys found a relatively wide range of boarding equipment for small aircraft manufactured and/or available in Canadian airports. These devices can be divided into five groups on the basis of their technical advancement:

- Boarding chairs and transfer chairs;
- Stair climbers;
- Mechanical lifts;
- Ramps;
- Boarding bridges (or low level boarding bridges).

Boarding chairs are the least technically advanced devices, requiring manual lifting or pulling the passenger in the chair up/down the aircraft stairs. Because of these operational features, boarding chairs carry an inherent risk of injury to the passenger and, since operating air carrier agents do not allow for integrated boarding, they cannot be considered as a dignified method of boarding. In these terms boarding chairs were evaluated as the least effective boarding device. Many boarding chairs also have shortcomings in their design, lack safety and ergonomic features, and thus are in general rather uncomfortable for the passenger. However, their price is relatively low, in the range of CAN$400 to $1000, making them affordable to all air carriers and airports.

Boarding bridges are the most technically advanced products. They have the advantage of allowing for integrated boarding of passengers with a disability and able-bodied passengers, and do not require manual lifting of the passenger in a chair up/down the stairs. Thus boarding bridges were evaluated as the most effective boarding device. However, bridges still require the use of the boarding or transfer chair to move the passenger to his or her seat in the aircraft. Bridges are very expensive devices, with costs starting at about CAN$150,000.

Most lift devices do not require manual lifting of the passenger up the aircraft stairs, either. As boarding bridges, they also require the use of a boarding chair. Lifts are less expensive than bridges (CAN$20,000 to $40,000), but unlike bridges they do not allow for integrated boarding of persons with disabilities and able-bodied passengers, and often do not provide any protection against inclement weather. Thus, in terms of effectiveness, lift devices fall between boarding chairs and bridges.

It should be noted that boarding chairs, stair climbers, lifts and bridges are used for the level-change operation, i.e. to raise the passenger using a wheelchair to the aircraft door. Boarding chairs and transfer chairs are used to move the passenger from the aircraft door to a seat in aircraft. Therefore, even the more advanced devices still require the use of a boarding or transfer chair to complete the boarding procedure.

Not all boarding devices can be used with all aircraft types. Some devices are not compatible with certain aircraft types. The level-change devices may be incompatible with the aircraft service door, and boarding and transfer chairs may be incompatible with the aircraft vestibule and aisles.

The analysis of collected data on compatibility of boarding devices with various small aircraft types indicates that:

- Stair climber is compatible with all aircraft types;
- Three lift models identified in the survey are compatible with all aircraft types, and three other models are compatible with a few frequently used aircraft types;
- Ramp device is compatible with all aircraft types (according to the manufacturer);
- Two models of boarding bridges are compatible only with some small aircraft. The DEW bridge is relatively flexible and is compatible with a relatively wide range of aircraft. In contrast, the APEX bridge is compatible only with five aircraft types;
- All boarding chairs identified are compatible with small aircraft stairs and service door (and thus are compatible with all aircraft as a level-change device);
- All boarding and transfer chairs are compatible with all small aircraft vestibules, except for Metroliner, and the only chair compatible with the vestibule of this aircraft is the Just Mobility chair;
- Most boarding and transfer chairs are compatible with the aisles of most small aircraft. However, there are compatibility problems with a few aircraft types – Metroliner, Beechcraft 1900D, HS 748, and ATR 42:
    - There is no boarding chair compatible with Metroliner;
    - Only one type of transfer chair, the Just Mobility chair, is compatible with Metroliner;
    - Beechcraft 1900D can be accessed only with the Columbia chair and only up to the first row. If access to seats beyond row one is required, the Just Mobility chair has to be used;
    - HS 748 is not compatible with the Washington chair;
    - HS 748 and ATR 42 are incompatible with a few other chair types used in the industry.

Boarding and transfer chairs were also evaluated in terms of operational features such as safety features (brakes, belts, etc.), ergonomic features (design of seat and back, availability of armrests and footrests, etc.), and ease of operation. The

analysis indicates that the Columbia chair is one of the better designed chairs and is significantly better than the commonly used Washington chair.

AVAILABILITY AND USE OF BOARDING DEVICES

The survey results showed that each airport surveyed has a boarding device, at least a boarding chair. Table 4 summarizes the results on the availability of various boarding devices.

Table 4: Availability of Boarding Devices in Canadian Airports

DEVICE	PERCENTAGE OF AIRPORTS USING	DEVICE	PERCENTAGE OF AIRPORTS USING
Washington	52%	Wiltshire chair	1.6%
Columbia	60%	Seat case	1.6%
E&J	10%	Mobilift	8%
Manten	8%	Just Mobility lift	1.6%
Just Mobility chair	4.8%	Elevator platform	1.6%
Aviator chair	1.6%	Lift-a-loft	4.8%
Loading chair	3.4%	PAL lift	29%
Invacare chair	1.6%	Lift truck	1.6%
Norton chair	1.6%		

As Table 4 demonstrates, boarding chairs, and in particular the Columbia chair and the Washington chair, are the most common boarding devices. Some airports have multiple devices: two or three types of boarding chairs, and up to two lift devices.

Although each of the airports in our sample had some type of boarding equipment for passengers using a mobility aid, an important question that arose is whether these devices are compatible with all small aircraft that use that airport.

The compatibility of each device in each airport was thus checked against small aircraft using that airport to determine whether some types of aircraft have no compatible boarding device. Since lifting devices require the use of a boarding

or transfer chair to move the passenger from the aircraft door to his or her seat, this involved two steps:

1. Checking the compatibility of level change devices, including lifts and boarding chairs, available in the given airport against aircraft types using that airport (i.e. checking compatibility of these devices with aircraft door); and

2. Checking the compatibility of the boarding and transfer chairs available in that airport against aircraft types using that airport (i.e. checking compatibility of boarding and transfer chairs with aircraft aisles).

Table 5 shows the results of the analysis.

Table 5: Availability of Compatible Level-Change Devices / Boarding and Transfer Chair Combinations in Airports of Various Sizes

AIRPORT SIZE	AIRPORTS WITH FULLY COMPATIBLE COMBINATIONS FOR ALL AIRCRAFT	AIRPORTS WITH AT LEAST PARTIALLY COMPATIBLE COMBINATIONS FOR ALL AIRCRAFT	AIRPORTS WITH NO COMPATIBLE COMBINATIONS FOR SOME AIRCRAFT
Large (50+ departures per day) 6 Airports	1 (16.7%)	2 (33.3%)	4 (66.7%)
Medium (20 – 50 departures per day) 8 Airports	4 (50%)	6 (75%)	2 (25%)
Small (Fewer than 20 departures per day) 48 Airports	22 (45.8%)	25 (52.1%)	23 (47.9%)
All Airports 62 Airports	**27 (43.5%)**	**33 (53.2%)**	**29 (46.7%)**

NOTE TO TABLE 5: Airports with fully compatible combinations of level-change devices and boarding/transfer chairs include airports where level-change devices are compatible with aircraft doors of all aircraft types served in that airport, and boarding and transfer chairs are compatible with the aisles of aircraft selected for detailed study in the second phase and served in that airport. Airports with at least partially compatible combinations of level-change devices and boarding/transfer chairs include airports with fully compatible combinations plus airports serving Beech 1900D and reporting to have the Columbia boarding chair. (As stated earlier, the first row in Beech 1900D can be accessed with the Columbia chair but not rows two and up.)

As shown in Table 5, some incompatibilities of aircraft and boarding devices do exist in Canadian airports. Although there were no airports in the sample where all aircraft types served were incompatible with boarding equipment, 46.7 percent of airports served an aircraft type for which the airport has no compatible combination of level-change devices and boarding or transfer chairs.

These incompatibilities are solely due to lack of boarding and transfer chairs compatible with the aisles of all aircraft types served in the given airport. Specifically, incompatibilities arise when the airport serves:

- Metroliner and the Just Mobility chair is not available;
- Beechcraft 1900D and the Just Mobility chair or the Columbia chair are not available; and
- HS 748 or ATR 42 and the Columbia chair or the Just Mobility chair (or a few other types of chairs) are not available.

The identified "problem" aircraft types accounted in early 2002 for about 18 percent of total flight volume.

LIVE BOARDING DEMONSTRATIONS

Live boarding/disembarkation demonstrations were carried out on the following aircraft types:

- Dash 8-100;
- Canadair Regional Jet (CRJ);
- Metroliner; and
- Beechcraft 1900D.

Demonstrations on the Dash 8-300 were deemed not necessary since this aircraft model differs from the Dash 8-100 model only by its length and the number of seats. Demonstrations on the HS 748 and ATR 42 were not possible as these aircraft types could only be examined in a maintenance centre in a stripped-down configuration without seats.

No obstacles to boarding were encountered in boarding exercises with the Dash 8-100 and CRJ. Disabled subjects who participated in these exercises could be boarded by trained carrier agents and according to the established procedure. The results of the demonstration showed that:

- Dash 8-100, Dash 8-300, and CRJ have good accessibility for passengers using a mobility aid.
- Access to rows two and up on both the Dash 8 and CRJ is substantially easier than to the first row because seats beyond the first row have pivoting armrests. However, seats in the first row could be more comfortable for individuals with certain disabilities because they have extended leg room.
- Boarding can pose an inherent risk of injury to both passenger and carrier agents due to the required lifting.
- Boarding involves physical contact between passenger and agents and may be considered unwelcome and undignified (particularly if the passenger is female).

Significant obstacles were encountered during boarding exercises with the Metroliner and Beechcraft 1900D, confirming the initial assessment of accessibility. The results of the demonstrations showed that:

- Both the Beechcraft 1900D and Metroliner have a very narrow aisle and a very tight vestibule.
- On the Metroliner, the aisle can be accessed only with the Just Mobility chair. On the Beechcraft 1900D, this chair is required to access rows two and up. Since the Just Mobility chair is not designed for carrying passengers up and down aircraft stairs, and since transferring from the Columbia/Washington chair to the Just Mobility chair in the aircraft vestibule is not possible, this implies that:

- Metroliner is accessible only when a lifting device (which raises a passenger in a chair to the aircraft door) and a Just Mobility chair are used.
- Beechcraft 1900D is accessible with the Columbia chair but only to the first row. Rows two and up can be accessed only with a Just Mobility chair, which also requires the use of a lifting device. Moreover, access may be difficult and considered undignified to any person whose body width exceeds 30 cm (12 in).

• In the Metroliner, as the distance from the vestibule to the seat in the first row is very short, carrier agents were able to transfer the subject to this seat. However, due to the tight space, this procedure was very difficult for the agents and uncomfortable for the passenger.

DEVELOPING BETTER INFORMATION FOR PASSENGERS AND POLICY

The need exists for comprehensive and consistently up-to-date information regarding the flight-by-flight availability of boarding devices in Canada.

Passengers with a disability could make their travel arrangements, such as selection of air carrier and travel destinations, on the basis of services provided to them – for example, whether a particular air carrier is able to carry an electric scooter, or whether a mechanical lift is provided in the departure and arrival airport.

Policy makers could analyze flight-specific information, or aggregate it to obtain data summaries by aircraft type, airport characteristic, boarding device type, boarding procedure, etc. This information could be used to assess trends in the use of boarding devices and procedures.

Consultations with travel agents have revealed that such information is not available in the form of a database that could be easily accessed through a computer at the touch of a key. Yet information about wheelchair boarding and stowage choices at the departure, arrival and connecting airports should be accessible and visible as part of routinely provided information in relation to every scheduled flight.

HLB attempted to develop a relational database with information on small aircraft and available boarding devices. However, the survey approach to

populate an effective database turned out to be an exercise with several constraints.

First, a relatively low survey return rate demonstrated that a third party, a consulting firm, cannot exert enough pressure on the target populations of airlines and airports to motivate them to participate in a survey and fill out a survey questionnaire. A database resulting from a survey administered by a consultant will thus likely have several gaps or uncertain information.

Second, the use of surveys provides only a "snapshot" of the market where small aircraft operate. Changes to particular flight details, changes in the carrier makeup itself, and other unanticipated departures from the initial snapshot mean that results quickly become obsolete.

These limitations prompted HLB to develop an alternative approach to establishing a database. This approach involves linking information on boarding equipment with other flight information in the OAG database. In other words, the OAG could collect information on available boarding devices along with the flight schedules and aircraft information that it already collects from air carriers on a regular basis. Such a solution would involve no cost to the government and very little additional cost to the air carriers and the OAG.

SUMMARY OF KEY FINDINGS

The key findings of this study are summarized in Box 1.

Box 1: Summary of Key Findings

FINDING 1. ***ALL AIRPORTS SURVEYED HAVE AT LEAST A BOARDING CHAIR, MANY HAVE A MECHANICAL LIFT, BUT NONE HAVE RAMPS AND THE MOST ADVANCED EQUIPMENT SUCH AS LOW-LEVEL BOARDING BRIDGES.***

Although all boarding devices satisfy basic safety requirements, the low-level boarding bridge provides the safest, most convenient and dignified boarding procedure for passengers who use wheelchairs. It also provides fully integrated boarding for passengers with and without a disability. This means that its safety and convenience benefits extend to the general public. Although the operation of low-level boarding bridges is no more costly in terms of labour and other resources than boarding chairs, most airports and airlines consider the front-end capital cost prohibitive.

FINDING 2. ***MOST OF THE IDENTIFIED EQUIPMENT IS COMPATIBLE WITH MOST SMALL AIRCRAFT TYPES. HOWEVER, CERTAIN INCOMPATIBILITIES DO EXIST. IN PARTICULAR, SEVERAL TYPES OF BOARDING AND TRANSFER CHAIRS ARE INCOMPATIBLE WITH METROLINER AND BEECHCRAFT 1900D AIRCRAFT.***

This means that access to these aircraft is limited and requires the use of certain transfer chairs and a lifting device. The Beechcraft can also be accessed with the Columbia boarding chair but only up to the first row. Metroliner and Beechcraft account for about 16 percent of the flight volume.

FINDING 3. ***THERE WERE NO AIRPORTS SURVEYED WHERE ALL AIRCRAFT TYPES SERVED ARE INCOMPATIBLE WITH THE BOARDING EQUIPMENT AVAILABLE IN THAT AIRPORT. HOWEVER, 46 PERCENT OF AIRPORTS SERVE AN AIRCRAFT TYPE FOR WHICH THE AIRPORT HAS NO COMPATIBLE COMBINATION OF LEVEL-CHANGE AND BOARDING OR TRANSFER CHAIR COMBINATION.***

These incompatibilities are solely due to lack of versatile boarding or transfer chairs compatible with aisles of all aircraft types served.

Box 1 (continued)

FINDING 4. ***DASH 8-100, DASH 8-300, AND CANADAIR REGIONAL JET ARE WELL ACCESSIBLE TO PASSENGERS USING A MOBILITY AID.***
These aircraft types account for 60 percent of the total flight volume.

FINDING 5. ***ACCESS TO CERTAIN SEATS IN SMALL AIRCRAFT IS EASIER THAN TO OTHERS.***
The transfer from a boarding chair to an aircraft seat with a pivoting armrest is substantially easier for the passenger and carrier agent. In several types of aircraft, including the Dash 8 and Canadair Regional Jet, the first row of seats has more leg room and would therefore be more accommodating to passengers with mobility impairments.

RECOMMENDATIONS

The following are recommended on the basis of the findings of the study. The first three recommendations are considered as the key recommendations of this study. A summary of the key recommendations is given in Box 2.

Box 2: Summary of Key Recommendations

RECOMMENDATION 1: ***FULL PASSENGER INFORMATION TO FACILITATE PASSENGER CHOICE AND PROMOTE PROVIDER COMPETITION***

Information about wheelchair boarding and stowage choices at the departure, arrival and connecting airports should be visible as part of routinely provided information in relation to every scheduled flight. This information should appear, again routinely, as part of every passenger's regular flight itinerary.

Air Mobius Flight 3035;
Leave Granola Intl. Airpt 0855; Dash 8; Snack; Columbia Chair
Arrive Canola Intl. Airpt 1019; Low-Level Loading Bridge, Just Mobility Chair

This recommendation should be executed by facilitating an extension to the Official Airline Guide (OAG), the continuously updated database that provides the foundation for most information available to travel agents and internet booking sites. With virtually no additional penalty in cost or time, airlines and airports could supply wheelchair boarding and stowage information to the OAG along with the flight schedules and aircraft information they already supply on a regular basis. Travel agents could then provide passengers with up-to-date information about the boarding technology and wheelchair stowage choices on all flights available for the desired trip. Passengers could then select the choice that best serves their needs; competition to present the best choice would be fostered, to the extent feasible, among airlines accordingly.

Box 2 (continued)

RECOMMENDATION 2: ***AN INNOVATIVE FINANCING SOLUTION BASED ON THE PUBLIC-PRIVATE PARTNERSHIP MODEL TO ENSURE LOW-LEVEL BOARDING BRIDGES AT ALL AIRPORTS WHERE SUCH SOLUTION IS ARCHITECTURALLY FEASIBLE***

A four-party public-private partnership (PPP) between the federal government, provincial governments, airlines, and airports should be created to bring about the availability of low-level boarding bridges for small aircraft. The relatively small scale of air travel demand among wheelchair users creates a "market failure" to provide equilibrium between the supply of, and demand for low-level boarding bridges. In short, there is insufficient financial incentive to generate the level of investment in low-level loading bridges that is justified by social cost-benefit criteria. This kind of market failure provides a powerful justification for public-private co-financing of low-level loading bridges. A business model should be developed immediately within which co-financing of at least one low-level loading bridge at each Canadian airport can be negotiated among the relevant parties, namely the federal and provincial government, the airline and the airport.

RECOMMENDATION 3: ***PUBLIC-PRIVATE CO-OPERATION TO FINANCE AND STEER DEVELOPMENT OF ACCESSIBLE SMALL AIRCRAFT INTERIOR LAYOUTS***

Research in non-aircraft vehicle domains (railway carriages and buses) indicates that accessible interior designs are feasible with virtually zero loss of regular passenger seating capacity (when no wheelchairs are on board). A jointly financed public-private research and development program should be launched with a view to extending such design concepts to the widest possible array of small aircraft in use for regular scheduled service.

RECOMMENDATION 1: *FULL PASSENGER INFORMATION TO FACILITATE PASSENGER CHOICE AND PROMOTE PROVIDER COMPETITION*

The experience of this study shows that a third party, such as a consulting firm, is unable to exert enough pressure on the target populations of companies to motivate them to participate in a survey, such as a survey of boarding devices, and fill out a detailed questionnaire. A database resulting from such a survey will likely have several gaps and inconsistencies.

Yet information on available boarding devices and boarding procedures must be public and available at the point where airline tickets are sold. Information about wheelchair boarding and stowage choices at the departure, arrival and connecting airports should be visible as part of routinely provided information in relation to every scheduled flight. This information should appear, again routinely, as part of every passenger's regular flight itinerary. Below is an example.

> *Air Mobius Flight 3035;*
> *Leave Granola Intl. Airpt 0855; Dash 8; Snack; Columbia Chair*
> *Arrive Canola Intl. Airpt 1019; Low-Level Loading Bridge, Just Mobility Chair*

Linking information on boarding equipment with other information in the OAG database is one possible bottom-line incentive for air carriers to co-operate and provide the requested information. The OAG is a continuously updated database that provides the foundation for most information available to travel agents and internet booking sites. With virtually no additional penalty in cost or time, airlines and airports could supply wheelchair boarding and stowage information to the OAG along with the flight schedules and aircraft information they already supply on a regular basis. Travel agents could then provide passengers with up-to-date information about the boarding technology and wheelchair stowage choices on all flights available for the desired trip. Passengers could then select the choice that best serves their needs; competition to present the best choice would be fostered, to the extent feasible, among airlines accordingly.

In addition, a database of boarding devices and procedures created in this way will be a truly dynamic and comprehensive database with the potential of

extensive use at the policy level. The execution of this initiative would involve no cost to the government.

RECOMMENDATION 2: *AN INNOVATIVE FINANCING SOLUTION BASED ON PUBLIC-PRIVATE PARTNERSHIP MODEL TO ENSURE BOARDING LIFTS OR LOW-LEVEL BOARDING BRIDGES AT ALL AIRPORTS WHERE SUCH SOLUTION IS FEASIBLE*

This study has demonstrated that due to the tight space, access to the Beechcraft 1900D and Metroliner is limited or not possible using a typical boarding chair. For these aircraft, a lift and a very narrow Just Mobility transfer chair are necessary to board a passenger who uses a wheelchair.

This study has also shown that carrying the passenger up and down aircraft stairs is a challenging task for both the passenger as well as carrier agents. It requires significant strength on the part of agents and some body control on the part of passenger. The risk of injury to both passenger and agents is inherent in this procedure. For safety reasons, manual carrying of the passenger in chair should be avoided whenever possible.

Thus, low-level loading bridges, or appropriate boarding lifts in all airports, would ensure safer access to small aircraft.

However, since the air carriers are responsible for boarding and expected to provide boarding equipment, financing is likely to present a significant problem. Small air carriers may be unable to purchase with their own funds boarding lifts and bridges for all of their destination airports. Moreover, the market for provision of accessible air travel services is too small to promote – on the basis of demand/supply considerations – effective boarding equipment for those air carriers who could afford to purchase it.

Yet there is a "public good", or social benefit, in having an effective boarding device, such as the low-level boarding bridge, available in most airports. Economists call such situations a market failure. The solution to the market failure problem is the provision of the good or service by the government. In this case, the market failure provides a powerful justification for public-private co-financing of low-level boarding bridges. A business model should be developed immediately within which co-financing of at least one low-level boarding bridge at each Canadian airport can be negotiated among the relevant parties, namely the federal and provincial government, the airline and the airport.

RECOMMENDATION 3: *PUBLIC-PRIVATE CO-OPERATION TO FINANCE AND STEER DEVELOPMENT OF ACCESSIBLE SMALL AIRCRAFT INTERIOR LAYOUTS*

Today, all types of small aircraft have a very small entrance vestibule and narrow aisles. A regular wheelchair cannot access these aircraft. It is thus necessary to use a narrow boarding or transfer chair in the boarding procedure. The results of live boarding demonstrations have shown that even access in a narrow chair can be difficult if not impossible. Therefore, improvements in the interior aircraft layout should be investigated. Ideally, the goal would be to re-design the cabin in such a way as to make a limited number of seats directly accessible from a regular wheelchair. At a minimum, aircraft should be easily accessible with all boarding chairs typically used in the industry.

Some options may exist in this area, and those that do not require a reduction in the total number of passenger seats aircraft type could be promoted as forward-going design recommendations. Research in non-aircraft vehicle domains (railway carriages and buses) indicates that accessible interior designs are feasible with virtually zero loss of regular passenger seating capacity (when no wheelchairs are on board). A jointly financed public-private research and development program should be launched with a view to extending such design concepts to the widest possible array of small aircraft in use for regular scheduled service.

RECOMMENDATION 4: *IMPROVEMENTS TO AIRCRAFT SEAT DESIGN IN ORDER TO MAKE THE ARMRESTS IN THE FIRST ROW MOVEABLE*

Although the armrests in rows two and up are moveable in the aircraft types examined, the armrests in the first row are not. (Typically, the armrest is used for storage of food trays.) Transfer of the passenger from boarding chair to aircraft seat over a fixed armrest is much more difficult than transfer to a seat with a moveable armrest. The first row also offers extended leg room and more space for manoeuvring the boarding chair, and does not require pushing the passenger in a boarding chair through the tight aircraft aisle. Therefore, whenever possible the seats in the first row should be used to accommodate passengers with a disability.

RECOMMENDATION 5: *STANDARDS FOR BOARDING CHAIR DESIGN THAT WOULD ADDRESS THE ERGONOMIC NEEDS OF PASSENGERS AND FACILITATE OPERATION BY CARRIER AGENTS*

At present, there are no standards for boarding chair designs, only guidelines developed by ATBLB in the United States over 10 years ago. Passengers who need boarding assistance often spend prolonged periods of time in a boarding or transfer chair. Ergonomic features that would ensure the comfort and safety of the passenger are thus essential. Moreover, a chair should have features that make it as easy as possible to operate for carrier agents, require minimum strength and involve minimum physical contact with the passenger during transport and transfers. The results of this study indicate that some chairs are better in these respects than others. Specifically, the Columbia chair is one of the better chairs and substantially better than the Washington chair. Thus, the less comfortable chairs should be phased out or improved.

RECOMMENDATION 6: *RESERVATION OF THE FIRST ROW FOR MOBILITY IMPAIRED PASSENGERS*

Boarding demonstrations carried out as part of this study showed that seating the passenger with mobility impairments in the first row is much easier than in rows two and up. The first row also has extended leg room that is required for the comfort of passengers with certain types of disabilities. At present, seating in the first row near the entrance is not allowed for passengers with mobility impairments due to safety regulations. However, seats in the first row opposite to the entrance door can be used to seat passengers with mobility impairments and could be reserved for this passenger group without regulatory changes.

RECOMMENDATION 7: *PUBLICLY FINANCED RESEARCH TO INVESTIGATE THE FEASIBILITY OF A BUILT-IN INTEGRATED BOARDING SYSTEM FOR SMALL AIRCRAFT TO BE USED IN SITUATIONS WHERE A LOW-LEVEL BOARDING BRIDGE IS NOT FEASIBLE*

Today, built-in lifts are available in many city buses and VIA Rail trains. A similar lift in airplanes would allow boarding of passengers with a disability in each and every airport where the particular airplane goes. This boarding mechanism would be more effective than a boarding chair and would make expensive mechanical lift devices unnecessary. Built-in lifts could thus be the most economical solution to air carriers and ensure consistent boarding in every airport and by each air carrier.

RECOMMENDATION 8: *GUIDELINES FOR TRANSFERS AND OTHER DETAILS OF BOARDING PROCEDURE*

At the present time, there are no specific Canadian policies or guidelines for accessibility to small aircraft or the boarding procedure itself. Air carriers provide services consistent with the notion of non-discrimination on the basis of disability and avoiding the creation of undue obstacles to travel. A set of standards or guidelines would ensure consistent and dignified treatment of passengers by all air carriers and in each airport.

SOMMAIRE

La présente étude porte sur les équipements et les procédures d'embarquement auxquels ont accès les personnes à mobilité réduite lorsqu'elles voyagent à bord des petits avions passagers (de 19 à 60 places) qui assurent un service à horaire fixe aux aéroports canadiens. L'information colligée et analysée avait trait à la disponibilité des équipements d'embarquement, à leur utilisation réelle, à leur coût, à leurs performances et à leur compatibilité avec les petits avions.

L'étude a comporté les grandes étapes suivantes :

1. Revue du cadre réglementaire régissant les petits avions au Canada et aux États-Unis;
2. Analyse, à partir de l'OAG (*Official Airline Guide*), des horaires des vols effectués à l'aide d'avions de 19 à 60 places (sur une certaine période déterminée);
3. Évaluation de la disponibilité et de la convenance de l'équipement de «transfert vertical», des fauteuils d'embarquement et de transfert, et des procédures d'embarquement utilisés pour faire monter à bord les passagers à mobilité réduite. Voici les moyens utilisés pour mener cette évaluation :
   - enquête auprès des fabricants concernant les équipements qu'ils produisent, les caractéristiques d'exploitation de ceux-ci et leur compatibilité avec les avions;
   - enquête auprès des administrations aéroportuaires concernant la disponibilité, l'utilisation réelle et les performances des équipements;
   - enquête auprès des transporteurs concernant la propriété, l'utilisation réelle et les performances des équipements;
4. Organisation d'un atelier réunissant les parties intéressées, au cours duquel ont été discutés les résultats des enquêtes et l'efficacité des équipements d'embarquement;
5. Inventaire et évaluation des fauteuils d'embarquement et de transfert;
6. Analyse de l'aménagement de la cabine passagers des types d'avions les plus couramment utilisés dans les services aériens à horaire fixe au Canada;

7. Démonstrations d'embarquements et de débarquements réels, mettant en jeu certains des types de petits avions les plus couramment utilisés dans les services aériens à horaire fixe au Canada.

Le projet a été réalisé en deux phases :

- La phase I (d'avril 2000 à octobre 2001) a comporté la revue du cadre réglementaire, la collecte et l'analyse de la base de données de l'OAG sur les petits avions en service au Canada, l'enquête auprès des fabricants d'équipements, des administrations aéroportuaires et des transporteurs aériens, l'analyse de l'information recueillie, et la tenue de l'atelier avec les parties intéressées.
- La phase II, qui était de fait le prolongement de la phase principale (de février 2002 à décembre 2002), a comporté la mise à jour des données sur les petits avions en service au Canada, l'analyse de l'aménagement intérieur et de l'accessibilité de la cabine de certains types d'avions, et les démonstrations d'embarquements réels.

PETITS AVIONS EN SERVICE AU CANADA ET AVIONS CHOISIS AUX FINS DE L'ÉTUDE DÉTAILLÉE

Le tableau 1 donne la liste des petits avions en service au Canada au début de 2002.

Tableau 1 : Liste des petits avions en service au Canada, classés selon le nombre des départs auxquels ils sont affectés

RANG*	NOM DE L'AVION	PLACES	POURCENTAGE DES VOLS	POURCENTAGE CUMULATIF DES VOLS
1	De Havilland DHC-8 Dash 8-100	37	30,87	30,87
2	Beechcraft 1900D	19	11,52	42,39
3	De Havilland DHC-8 Dash 8-300	50	11,34	53,74

Tableau 1 (suite)

RANG*	NOM DE L'AVION	PLACES	POURCENTAGE DES VOLS	POURCENTAGE CUMULATIF DES VOLS
4	Canadair Regional Jet	50	10,35	64,09
5**	De Havilland DHC8 Dash 8 (100 et 300)	37-50	7,07	71,15
6	Saab SF 340	34	4,95	76,10
7	De Havilland DHC-6 Twin Otter	19	4,86	80,96
8	Fairchild Metroliner	19	4,59	85,55
9	Shorts 360	33	2,57	88,12
10	Embraer RJ 135 /140 /145	37-50	2,52	90,64
11	BAe (HS) 748	37-46	1,62	92,26
12	Embraer RJ135	37	1,49	93,74
13	Beechcraft, toutes séries	19	1,40	95,14
14	BAe Jetstream 31	19	1,26	96,40
15	Fairchild Dornier 328	29	0,81	97,21
16	ATR, toutes séries	37-50	0,63	97,84
17	Fairchild Dornier 328 Jet	32	0,63	98,47
18	Boeing 727 (configuration mixte)	19	0,59	99,05
19	Embraer EMB-120	30	0,54	99,59
	Brasilia			
20	Douglas DC3 /C-47 Dakota (passagers)	27	0,18	99,77
21	Embraer RJ140	50	0,18	99,95
22	ATR 42	37	0,05	100,00

NOTES SE RAPPORTANT AU TABLEAU 1 :

*Les avions sont classés selon leur niveau d'activité, c.-à-d. selon le pourcentage des vols qu'ils assurent. On aurait pu penser à un classement selon

le nombre de passagers transportés, mais les données nécessaires n'étaient pas disponibles.
**La catégorie De Havilland DHC-8 Dash 8 (100 et 300) comprend le Dash 8-100 et le Dash 8-300. On y a regroupé les vols pour lesquels l'OAG ne précisait pas le type d'avion (Dash 8-100 ou Dash 8-300).

SOURCE : OAG (*Official Airline Guide*), échantillon de données couvrant la période du 4 au 10 février 2002.

Le tableau 1 indique que 7 des 21 types d'avions (De Havilland DHC-8 Dash 8-100, De Havilland DHC-8 Dash 8-300, Beechcraft 1900D, Canadair Regional Jet, Saab SF 340, De Havilland DHC-6 Twin Otter et Fairchild Metroliner) assurent plus de 85 p. 100 des vols, ce qui laisse 15 p. 100 des vols aux 14 autres types d'avions.

TRANSPORTEURS EXPLOITANT DES PETITS AVIONS

Le tableau 2 comprend la liste des transporteurs aériens qui utilisaient des petits avions pour assurer des services à horaire fixe au Canada au début de 2002.

Tableau 2 : Transporteurs aériens exploitant des petits avions au Canada

RANG	TRANSPORTEUR	POURCENTAGE DES VOLS	POURCENTAGE CUMULATIF DES VOLS
1	Air Canada	62,29	62,29
2	Bearskin Airlines	4,28	66,56
3	Delta Air Lines	3,29	69,85
4	Pacific Coastal Airlines Limited	3,11	72,95
5	Labrador Airways	2,97	75,92
6	Continental Airlines	2,93	78,85
7	First Air	2,79	81,64
8	Provincial Airlines	2,66	84,29
9	Air Creebec (1994) Inc.	2,48	86,77

Tableau 2 (suite)

RANG	TRANSPORTEUR	POURCENTAGE DES VOLS	POURCENTAGE CUMULATIF DES VOLS
10	Alaska Airlines	2,43	89,20
11	US Airways	1,94	91,13
12	Aklak Air	1,35	92,48
13	American Airlines	1,17	93,65
14	Harbour Air Ltd	1,08	94,73
15	Northwest Airlines	0,81	95,54
16	Hawkair	0,72	96,26
17	Northwestern Air Lease Ltd.	0,63	96,89
18	United Airlines	0,54	97,43
19	Air North	0,45	97,88
20	Calm Air Intl Ltd	0,45	98,33
21	Transwest Air	0,41	98,74
22	Skyward Aviation Ltd	0,36	99,10
23	America West Airlines	0,27	99,37
24	Pem-Air	0,23	99,59
25	Buffalo Airways Ltd.	0,18	99,77
26	Midwest Express Airlines Inc.	0,18	99,95
27	Air Saint-Pierre	0,05	100,00

SOURCE : OAG (*Official Airline Guide*), échantillon de données couvrant la période du 4 au 10 février 2002.

Le tableau 2 montre que 27 compagnies aériennes utilisaient des petits avions aux fins d'assurer des services à horaire fixe au Canada. Le transporteur le plus important à cet égard était Air Canada, qui assurait plus de 62 p. 100 de tous les vols. Bearskin Airlines arrivait deuxième, avec quelque 4 p. 100 des vols.

Quelques-uns des transporteurs figurant dans la liste sont des transporteurs établis aux États-Unis, qui offrent des liaisons transfrontalières Canada – États-Unis.

TYPES D'AVIONS CHOISIS AUX FINS DE L'ÉTUDE DÉTAILLÉE

Le tableau 3 comprend les cinq principaux exploitants de petits avions parmi les transporteurs aériens du Canada, ainsi que les types de petits avions qu'ils utilisaient, en février 2002.

Tableau 3 : Les cinq principaux exploitants de petits avions au Canada et la composition de leur flotte

TYPE D'AVION/ TRANSPORTEUR	Air Canada	Bearskin Airlines	Pacific Coastal Airlines	Labrador Airways	First Air
De Havilland DHC-8 Dash 8 100	X				X
Beechcraft 1900D	X		X	X	X
De Havilland DHC-8 Dash 8 300	X				X
Canadair Regional Jet	X				
Saab SF 340	X				
De Havilland DHC-6 Twin Otter				X	
Fairchild Metroliner		X			
Shorts 360			X		
BAe (HS) 748	X				X
Boeing 727					X

Le tableau 3 offrait une première liste de types d'avions aux fins de l'étude détaillée. Il a fallu restreindre cette liste pour ne retenir que les types d'avions qui seraient accessibles à l'équipe de recherche aux aéroports d'Ottawa, de Montréal (Dorval) ou de Toronto, aux fins d'inspection. Voici donc la liste

définitive des types d'avions retenus pour l'étude détaillée et les démonstrations d'embarquements réels :

- Dash 8-100;
- Dash 8-300;
- Beechcraft 1900D;
- Canadair Regional Jet;
- Metroliner;
- HS 748.

L'ATR 42 a été ajouté à cette liste, après qu'un des transporteurs eut indiqué qu'il était en voie d'acquérir un nombre appréciable d'appareils neufs de ce type.

Les types d'avions choisis aux fins de l'étude détaillée comptent pour plus de 77 p. 100 du volume des vols (selon le nombre de départs) effectués par des petits avions.

TENDANCES OBSERVÉES EN CE QUI A TRAIT À L'UTILISATION DE PETITS AVIONS PAR LES TRANSPORTEURS CANADIENS

Des entrevues menées avec les transporteurs se sont dégagées les tendances ci-après en ce qui a trait à l'utilisation des divers types de petits avions :

1. Air Canada a décidé de retirer complètement du service ses avions Fokker 28 en septembre 2002.
2. Air Canada a commencé à abandonner graduellement sa flotte de six Beechcraft 1900 pour la céder à Georgian Airlines en septembre 2002. Air Canada n'exploitera plus ce type d'appareil sur aucune de ses routes. Georgian Airlines a conclu une entente avec Air Canada, selon laquelle elle assurera des services de transport régional à partir de l'aéroport Pearson. Georgian Airlines exploite déjà plusieurs Beechcraft 1900.
3. À l'avenir, les Dash 8 vieillissants seront remplacés par des Regional Jets, des Dash 8 neufs ou des ATR 42.
4. First Air a passé une commande de plusieurs ATR 42 neufs.

ÉQUIPEMENTS D'EMBARQUEMENT POUR PETITS AVIONS EN USAGE, CARACTÉRISTIQUES D'EXPLOITATION ET EFFICACITÉ

Les enquêtes ont révélé l'existence d'une gamme relativement étendue d'équipements d'embarquement pour petits avions, de fabrication canadienne ou étrangère, dans les aéroports canadiens. Ces équipements peuvent être divisés en cinq catégories, d'après leur degré de complexité technique :

- Fauteuils d'embarquement et de transfert;
- Sièges ascenseurs d'escalier;
- Plate-formes élévatrices;
- Rampes d'accès;
- Passerelles d'embarquement (ou passerelles d'embarquement niveau sol).

Les fauteuils d'embarquement sont les équipements les plus simples sur le plan technique : une fois le passager installé, on le soulève ou on le tire à la force des bras dans l'escalier qui mène à la cabine. Mais leur utilisation n'est pas sans danger pour le passager. Et, comme ce sont les préposés de la compagnie aérienne qui «manutentionnent» la personne handicapée, celle-ci ne peut monter à bord en même temps que les autres passagers. De plus, cette méthode est jugée peu respectueuse de la dignité de la personne. Pour toutes ces raisons, le fauteuil d'embarquement est considéré comme le moins efficace des équipements d'embarquement. Par ailleurs, de nombreux fauteuils d'embarquement présentent des lacunes sur les plans de la conception, de la sûreté et de l'ergonomie, et sont plutôt inconfortables pour le passager. Mais comme leur coût est faible, de l'ordre de 400 à 1 000 $CAN, ils sont à la portée de tous les transporteurs et de tous les aéroports.

Les passerelles d'embarquement sont les équipements les plus complexes sur le plan technique. Avantages notables, l'embarquement est simultané pour tous les passagers et le personnel n'a pas à gravir l'escalier de l'avion en portant la personne à mobilité réduite à la force des bras. Ces équipements sont donc considérés comme les plus efficaces. Mais ils n'éliminent pas tout à fait le recours à un fauteuil d'embarquement ou de transfert : ce dernier est en effet nécessaire pour amener le passager à son siège. Ces équipements sont très coûteux, les moins chers revenant à environ 150 000 $CAN.

À l'instar des passerelles, la plupart des plates-formes élévatrices éliminent le besoin de porter à la force des bras le passager dans l'escalier, mais nécessitent

le recours à un fauteuil d'embarquement. Les plates-formes élévatrices sont moins coûteuses que les passerelles (20 000 à 40 000 $CAN), mais contrairement aux passerelles, elles ne permettent pas l'embarquement simultané des personnes handicapées et des autres passagers, et offrent rarement une protection contre les intempéries. Ainsi, au chapitre de l'efficacité, les plates-formes élévatrices se classent entre les fauteuils d'embarquement et les passerelles d'embarquement.

Il convient de noter que les fauteuils d'embarquement, les sièges ascenseurs d'escalier, les plates-formes élévatrices et les passerelles sont utilisés pour le transfert vertical, c.-à-d. pour hisser le passager et le fauteuil roulant jusqu'à la porte de l'avion. Il faut encore recourir à un fauteuil d'embarquement ou de transfert pour amener le passager de la porte à son siège. Ainsi, même lorsqu'on peut compter sur les équipements les plus complexes, on ne peut pas encore se passer du fauteuil d'embarquement ou de transfert pour mener à bonne fin la procédure d'embarquement.

Les équipements d'embarquement ne conviennent pas tous à tous les types d'avions. Par exemple, les dispositifs de transfert vertical peuvent être incompatibles avec la porte de service de l'avion, et les fauteuils d'embarquement et de transfert, avec le vestibule d'accueil et le couloir central.

L'analyse des données recueillies concernant la compatibilité des équipements d'embarquement avec divers types de petits avions a révélé ce qui suit :

- Le siège ascenseur d'escalier convient à tous les types d'avions;
- Trois modèles de plates-formes élévatrices recensés au cours de l'étude conviennent à tous les types d'avions, et trois autres sont compatibles avec quelques-uns des types d'avions couramment utilisés;
- Les rampes d'accès sont compatibles avec tous les types d'avions (selon le fabricant);
- Deux modèles de passerelles d'embarquement sont compatibles avec certains petits avions seulement. La passerelle DEW est assez facilement adaptable et elle convient à une gamme relativement étendue d'avions. Par contraste, la passerelle APEX n'est compatible qu'avec cinq types d'avions;
- Tous les fauteuils d'embarquement recensés sont compatibles avec les escaliers et les portes de service de tous les petits avions étudiés (et peuvent donc servir au transfert vertical pour tous les avions);

- Tous les fauteuils d'embarquement et de transfert sont compatibles avec le vestibule d'accueil de tous les petits avions, à l'exception du Metroliner. Le seul fauteuil adapté au vestibule de cet avion est le fauteuil *Just Mobility*;
- La plupart des fauteuils d'embarquement et de transfert peuvent circuler dans le couloir de la plupart des petits avions. Mais le couloir de certains types d'avions – Metroliner, Beechcraft 1900D, HS 748, ATR 42 – posent problème :
    - aucun fauteuil d'embarquement n'est compatible avec le Metroliner;
    - un seul type de fauteuil de transfert, le *Just Mobility*, est compatible avec le Metroliner;
    - seul le fauteuil *Columbia* permet l'accès au Beechcraft 1900D, et encore seulement à la première rangée. Pour atteindre les autres rangées, il faut un fauteuil de transfert *Just Mobility*;
    - le HS 748 n'est pas compatible avec le fauteuil Washington;
    - le HS 748 et l'ATR 42 sont incompatibles avec quelques autres types de fauteuils utilisés dans l'industrie.

Les fauteuils d'embarquement et de transfert ont aussi été évalués en fonction de leurs caractéristiques d'exploitation, soit les dispositifs de sécurité (freins, sangles, etc.) et les caractéristiques ergonomiques (conception du siège et du dossier, présence d'accoudoirs et de repose-pieds, etc.), et de leur facilité d'utilisation. Il est ressorti de cette analyse que le fauteuil *Columbia* est l'un des mieux conçus et qu'il est de beaucoup supérieur au fauteuil *Washington*, d'utilisation courante.

DISPONIBILITÉ ET UTILISATION RÉELLE DES ÉQUIPEMENTS D'EMBARQUEMENT

Chacun des aéroports recensés dispose d'un équipement d'embarquement, ne serait-ce que d'un fauteuil d'embarquement. Le tableau 4 présente un sommaire des données sur la disponibilité des divers équipements d'embarquement dans les aéroports.

Tableau 4: Disponibilité des équipements d'embarquement dans les aéroports canadiens

ÉQUIPEMENT	POURCENTAGE DES AÉROPORTS UTILISATEURS	ÉQUIPEMENT	POURCENTAGE DES AÉROPORTS UTILISATEURS
Fauteuil *Washington*	52 %	Fauteuil *Wiltshire*	1,6 %
Fauteuil *Columbia*	60 %	Fauteuil de bord *Seat Case*	1,6 %
Fauteuil *E&J*	10 %	Appareil de levage *Mobilift*	8%
Fauteuil *Manten*	8 %	Appareil de levage *Just Mobility*	1,6 %
Fauteuil *Just Mobility*	4,8 %	Plate-forme élévatrice	1,6 %
Fauteuil *Aviator*	1,6 %	Plate-forme *Lift-a-loft*	4,8 %
Siège ascenseur	3,4 %	Appareil de levage *PAL*	29 %
Fauteuil *Invacare*	1,6 %	Chariot élévateur	1,6 %
Fauteuil *Norton*	1,6		

Comme le montre le tableau 4, les fauteuils d'embarquement, et en particulier les fauteuils *Columbia* et *Washington*, sont les équipements d'embarquement les plus courants. Certains aéroports possèdent plusieurs équipements : deux ou trois types de fauteuils d'embarquement, et jusqu'à deux appareils de levage.

Ayant constaté que tous les aéroports de l'échantillon disposaient d'un équipement d'embarquement pour passagers utilisant une aide à la mobilité, les chercheurs se sont posé une question importante, à savoir si dans chaque cas, l'équipement était compatible avec tous les petits avions qui desservent l'aéroport.

Ils ont donc étudié la compatibilité de chaque équipement recensé dans chaque aéroport avec les petits avions qui desservent cet aéroport, de façon à déterminer s'il existe des aéroports où certains types d'avions sont inaccessibles aux personnes installées dans un fauteuil d'embarquement. Étant donné que, dans le cas des appareils de levage, il faut prévoir un fauteuil d'embarquement ou de transfert pour amener le passager de la porte de l'avion au siège qui lui a été assigné, la vérification s'est faite en deux étapes :

1. Vérification de la compatibilité des équipements de transfert vertical (appareils de levage et fauteuils d'embarquement) disponibles à un aéroport donné avec les types d'avions qui desservent cet aéroport (c.-à-d. vérification de la compatibilité de ces dispositifs avec la porte de l'avion);

2. Vérification de la compatibilité des fauteuils d'embarquement et de transfert disponibles à cet aéroport avec les types d'avions qui desservent cet aéroport (c.-à-d. vérification de la compatibilité des fauteuils d'embarquement et de transfert avec les couloirs des avions).

Le tableau 5 donne les résultats de cette analyse.

Tableau 5 : Disponibilité de combinaisons compatibles de dispositifs de transfert vertical/fauteuils d'embarquement et de transfert dans les aéroports de différentes tailles

TAILLE DE L'AÉROPORT	AÉROPORTS À COMBINAISONS PARFAITEMENT COMPATIBLES AVEC TOUS LES AVIONS	AÉROPORTS À COMBINAISONS AU MOINS PARTIELLEMENT COMPATIBLES AVEC TOUS LES AVIONS	AÉROPORTS SANS AUCUNE COMBINAISON COMPATIBLE AVEC AUCUN AVION
Gros (au moins 50 départs/jour) 6 aéroports	1 (16,7 %)	2 (33,3 %)	4 (66,7 %)

Tableau 5 (suite)

TAILLE DE L'AÉROPORT	AÉROPORTS À COMBINAISONS PARFAITEMENT COMPATIBLES AVEC TOUS LES AVIONS	AÉROPORTS À COMBINAISONS AU MOINS PARTIELLEMENT COMPATIBLES AVEC TOUS LES AVIONS	AÉROPORTS SANS AUCUNE COMBINAISON COMPATIBLE AVEC AUCUN AVION
Moyen (20 à 50 départs/jour) 8 aéroports	4 (50 %)	6 (75 %)	2 (25 %)
Petit (moins de 20 départs/jour) 48 aéroports	22 (45,8 %)	25 (52,1 %)	23 (47,9 %)
Tous les aéroports 62 aéroports	**27 (43,5 %)**	**33 (53,2 %)**	**29 (46,7 %)**

NOTE SE RAPPORTANT AU TABLEAU 5 : Les aéroports désignés comme possédant des combinaisons pleinement compatibles d'équipements de transfert vertical et de fauteuils d'embarquement/de transfert comprennent les aéroports où les équipements de transfert vertical sont compatibles avec les portes de tous les types d'avions qui desservent cet aéroport, et où les fauteuils d'embarquement et de transfert sont compatibles avec les couloirs des avions choisis aux fins de l'étude détaillée de la deuxième phase de l'étude, et qui atterrissent à cet aéroport. Les aéroports désignés comme possédant des combinaisons au moins partiellement compatibles d'équipements de transfert vertical et de fauteuils d'embarquement/de transfert comprennent les aéroports qui possèdent des combinaisons d'équipements pleinement compatibles auxquels s'ajoutent les aéroports desservis par le Beech 1900D et qui ont déclaré posséder un fauteuil d'embarquement *Columbia*. (Comme il a déjà été mentionné, le fauteuil *Columbia* permet d'amener un passager à un siège de la première rangée du Beech 1900D, mais pas plus loin.)

Comme le montre le tableau 5, il existe des aéroports canadiens qui ne possèdent pas les équipements d'embarquement nécessaires à l'un ou l'autre des types d'avions qui y font escale. Même si l'échantillon ne comportait aucun aéroport doté d'équipements d'embarquement tous incompatibles avec tous les types d'avions qui le desservent, une proportion appréciable de 46,7 p. 100 étaient desservis par un type d'avion pour lequel ils ne disposaient pas d'une combinaison compatible d'équipement de transfert vertical et de fauteuil d'embarquement ou de transfert.

Ces incompatibilités sont uniquement attribuables à l'absence de fauteuil d'embarquement et de transfert compatible avec les couloirs des types d'avions qui font escale à l'aéroport en question. Plus précisément, des problèmes de compatibilité se posent lorsque l'aéroport est desservi par :

- un avion Metroliner et qu'il ne dispose pas d'un fauteuil *Just Mobility*;
- un avion Beechcraft 1900D et qu'il ne dispose pas d'un fauteuil *Just Mobility* ou *Columbia*;
- un avion HS 748 ou ATR 42 et qu'il ne dispose pas d'un fauteuil *Columbia* ou *Just Mobility* (ou de quelques autres types de fauteuils).

Les types d'avions «problèmes» mentionnés ci-dessus comptaient, au début de 2002, pour environ 18 p. 100 du volume de vols total.

DÉMONSTRATIONS D'EMBARQUEMENTS RÉELS

Des démonstrations d'embarquements/débarquements réels ont été réalisées à l'aide des types d'avions suivants :

- Dash 8-100;
- Canadair Regional Jet (CRJ);
- Metroliner;
- Beechcraft 1900D.

Il a été jugé superflu d'intégrer le Dash 8-300 aux démonstrations, car cet avion ne diffère du Dash 8-100 que par la longueur et le nombre de places. Quant au HS 748 et à l'ATR 42, ils ont dû être écartés des démonstrations, car l'équipe de recherche n'a pu examiner ces types d'avions que dans un centre d'entretien, où ils avaient été dépouillés de leurs sièges.

Aucun obstacle à l'embarquement n'a été observé au cours des exercices mettant en jeu le Dash 8-100 le CRJ. Les sujets handicapés qui ont participé aux exercices ont pu monter à bord avec l'aide de préposés spécialement formés, et conformément à la procédure établie. Les démonstrations ont révélé ce qui suit :

- Le Dash 8-100, le Dash 8-300 et le CRJ sont faciles d'accès pour les passagers qui utilisent une aide à la mobilité.
- À bord du Dash 8 comme à bord du CRJ, il est beaucoup plus facile de s'installer dans les sièges de la deuxième rangée (et des rangées suivantes) que dans la première rangée, parce qu'au delà de la première rangée, les sièges sont munis d'accoudoirs relevables. Mais pour certaines personnes handicapées, les sièges de la première rangée peuvent être plus confortables, car ils offrent un plus grand espace pour les jambes.
- L'embarquement peut poser un risque inhérent de blessure tant pour le passager que pour les préposés qui le transportent, car le passager doit être soulevé à la force des bras.
- L'embarquement nécessite un contact physique entre le passager et les préposés, ce qui peut être considéré comme déplacé et comme portant atteinte à la dignité (surtout lorsqu'il s'agit d'une passagère).

D'importants obstacles ont été rencontrés lors des exercices d'embarquement à bord du Metroliner et du Beechcraft 1900D, ce qui a confirmé la première évaluation de l'accessibilité de ces appareils. Voici les résultats de ces démonstrations :

- Le couloir du Beechcraft 1900D et du Metroliner est très étroit et le vestibule d'accueil, très exigu.
- Le couloir du Metroliner n'est accessible qu'en fauteuil *Just Mobility*. Dans le Beechcraft 1900D, il faut aussi recourir à ce fauteuil pour atteindre les rangées au delà de la première rangée. Or, comme le fauteuil *Just Mobility* n'est pas conçu pour transporter des passagers dans des escaliers, et comme le vestibule de l'avion est trop petit pour permettre le transfert d'un fauteuil *Columbia* ou *Washington* au fauteuil *Just Mobility*, il s'ensuit que :
    - l'accès au Metroliner nécessite le recours à un dispositif de transfert vertical (qui amène le passager en fauteuil roulant jusqu'à la porte de l'avion) et à un fauteuil *Just Mobility*.

- le Beechcraft 1900D est accessible en fauteuil *Columbia*, mais seulement jusqu'à la première rangée. Pour atteindre la deuxième rangée et les rangées suivantes, il faut un fauteuil *Just Mobility*, ce qui suppose le recours à un dispositif de transfert vertical. De plus, la manœuvre peut être malaisée, et risque de porter atteinte à la dignité de toute personne dont le tronc dépasse 30 cm (12 po) de largeur.

- Dans le cas du Metroliner, comme le siège de la première rangée est très près du vestibule d'accueil, les préposés ont pu déposer le sujet dans son siège. Mais à cause de l'espace très réduit, la manœuvre a été très difficile pour les préposés et inconfortable pour le passager.

AMÉLIORATION DE L'INFORMATION MISE À LA DISPOSITION DES PASSAGERS ET DES DÉCIDEURS

Il est impérieux de disposer d'une information complète et continuellement à jour sur la disponibilité des équipements d'embarquement pour chaque vol effectué au Canada.

Les passagers handicapés munis d'une telle information pourraient faire leurs préparatifs de voyage, c.-à-d. choisir un transporteur aérien et une destination, en fonction des services qui leur sont offerts – p. ex., de la capacité du transporteur de transporter son fauteuil électrique tricycle, ou de la présence d'une plate-forme élévatrice aux aéroports de départ et d'arrivée.

Quant aux décideurs, ils pourraient analyser les données se rapportant à un vol particulier, ou encore regrouper ces données selon un type d'avion, une caractéristique d'aéroport, un type d'équipement d'embarquement, une procédure d'embarquement, etc. Ils pourraient utiliser cette information pour cerner les tendances en matière d'utilisation réelle des équipements et procédures d'embarquement.

Des consultations avec les agents de voyage ont révélé que cette information n'existe pas sous forme de base de données facilement accessible par ordinateur. Or, ils devraient avoir accès aux données sur les modalités d'embarquement et de rangement des fauteuils roulants aux aéroports de départ, d'arrivée et de correspondance en même temps qu'aux autres renseignements sur les vols réguliers, qui leur sont fournis automatiquement.

HLB a tenté d'élaborer une base de données relationnelles à partir de l'information sur les petits avions et sur les équipements d'embarquement disponibles. Mais la méthode d'enquête pose de multiples contraintes lorsque vient le temps de constituer une base de données valable.

Premièrement, un taux de réponse relativement faible a démontré qu'une tierce partie, une firme de consultants, n'a pas suffisamment d'ascendant sur les populations cibles (sociétés aériennes et administrations aéroportuaires) pour les motiver à participer à une enquête et à remplir un questionnaire. D'où la probabilité qu'une base de données fondée sur les réponses à une enquête menée par un consultant comporte des lacunes ou des données douteuses.

Deuxièmement, les enquêtes ne procurent qu'un «instantané» du marché dans lequel les petits avions exercent leurs activités. Tout changement apporté aux données relatives à un vol ou à la composition de la flotte d'un transporteur, et toute variation imprévue par rapport au tableau de départ, peuvent rapidement rendre les résultats de l'enquête périmés.

C'est pourquoi HLB a pensé à une autre méthode pour constituer une base de données. Cette méthode consiste à établir des liens entre l'information sur les équipements d'embarquement et d'autres données figurant dans la base de données de l'OAG. Autrement dit, les responsables de l'OAG pourraient recueillir l'information sur les équipements d'embarquement disponibles en même temps que l'information sur les horaires de vol et les types d'appareils qu'elle collige déjà périodiquement auprès des transporteurs aériens. Une telle démarche ne coûterait rien au gouvernement et représenterait des coûts supplémentaires minimes pour les transporteurs et les responsables de l'OAG.

SOMMAIRE DES PRINCIPALES CONCLUSIONS

Les principales conclusions de l'étude sont résumées dans l'encadré 1.

Encadré 1 : Sommaire des principales conclusions

CONCLUSION 1. ***TOUS LES AÉROPORTS RECENSÉS DISPOSENT D'AU MOINS UN FAUTEUIL ROULANT D'EMBARQUEMENT, BEAUCOUP POSSÈDENT UNE PLATE-FORME ÉLÉVATRICE, MAIS AUCUN N'EST DOTÉ D'UNE RAMPE D'ACCÈS OU DE L'ÉQUIPEMENT LE PLUS MODERNE, À SAVOIR UNE PASSERELLE D'EMBARQUEMENT NIVEAU SOL.***

Tous les équipements d'embarquement recensés remplissent les critères de sécurité de base. Mais la passerelle d'embarquement niveau sol est l'équipement qui permet l'embarquement le plus sûr, le plus commode et le plus respectueux de la dignité des passagers en fauteuil roulant. Il permet aussi à tous les passagers, handicapés ou non, de monter à bord en même temps. Cela signifie donc que le grand public profite aussi des avantages qu'offre cet équipement sur les plans de la sécurité et de la commodité. Même si l'exploitation d'une passerelle d'embarquement niveau sol ne coûte pas plus cher, notamment en personnel, que les fauteuils d'embarquement, la plupart des administrations aéroportuaires et des sociétés aériennes considèrent les coûts initiaux d'acquisition prohibitifs.

CONCLUSION 2. ***À QUELQUES EXCEPTIONS PRÈS, LES ÉQUIPEMENTS RECENSÉS SONT COMPATIBLES AVEC LA PLUPART DES TYPES DE PETITS AVIONS. TOUTEFOIS, PLUSIEURS TYPES DE FAUTEUILS D'EMBARQUEMENT ET DE TRANSFERT SONT INCOMPATIBLES AVEC LE METROLINER ET LE BEECHCRAFT 1900D.***

Cela signifie que l'accès à ces avions est limité et qu'il nécessite le recours conjugué à un dispositif de transfert vertical et à certains types de fauteuils de transfert. Le Beechcraft est aussi accessible en fauteuil d'embarquement *Columbia*, mais seulement jusqu'à la première rangée. Le *Metroliner* et le *Beechcraft* comptent pour environ 16 p. 100 du volume des vols.

Encadré 1 (suite)

CONCLUSION 3. ***AUCUN DES AÉROPORTS RECENSÉS N'EST DESSERVI PAR DES TYPES D'AVIONS QUI SONT TOUS INCOMPATIBLES AVEC LES ÉQUIPEMENTS D'EMBARQUEMENT DISPONIBLES À CET AÉROPORT. TOUTEFOIS, 46 P. 100 DES AÉROPORTS SONT DESSERVIS PAR UN TYPE D'AVION POUR LEQUEL ILS NE POSSÈDENT PAS DE COMBINAISON D'ÉQUIPEMENT DE TRANSFERT VERTICAL ET DE FAUTEUIL D'EMBARQUEMENT OU DE TRANSFERT COMPATIBLE.***

Ces incompatibilités sont uniquement dues à l'absence de fauteuil d'embarquement ou de transfert compatible avec les couloirs de tous les types d'avions qui font escale à l'aéroport.

CONCLUSION 4. ***LE DASH 8-100, LE DASH 8-300 ET LE CANADAIR REGIONAL JET SONT TRÈS FACILES D'ACCÈS AUX PASSAGERS QUI UTILISENT UNE AIDE À LA MOBILITÉ.***

Ces types d'avions comptent pour 60 p. 100 du volume de vols total.

CONCLUSION 5. ***DANS LES PETITS AVIONS, CERTAINS SIÈGES SONT PLUS FACILES D'ACCÈS QUE D'AUTRES***

Les accoudoirs de siège relevables facilitent beaucoup le transfert du fauteuil d'embarquement au siège de l'avion, tant pour le passager que pour le préposé. Dans plusieurs types d'avions, dont le Dash 8 et le Canadair Regional Jet, la première rangée de sièges offre davantage d'espace pour les jambes et pourrait donc accueillir plus facilement les passagers à mobilité réduite.

RECOMMANDATIONS

Les recommandations ci-après découlent des conclusions tirées de l'étude. Les trois premières sont considérées comme les recommandations clés de l'étude. L'encadré 2 contient le résumé des recommandations clés.

Encadré 2 : Résumé des recommandations clés

RECOMMANDATION 1 : ***FOURNIR TOUTE L'INFORMATION DONT ONT BESOIN LES PASSAGERS POUR FAIRE DE MEILLEURS CHOIX ET FAVORISER AINSI LA CONCURRENCE ENTRE FOURNISSEURS***

L'information sur les modalités d'embarquement et de rangement des fauteuils roulants aux aéroports de départ, d'arrivée et de correspondance devrait s'afficher automatiquement en même temps que les autres types d'information sur chaque vol régulier. Cette information devrait figurer, encore là automatiquement, sur l'itinéraire de vol de chaque passager. Exemple :

> *Air Mobius Vol 3035;*
> *Départ Granola Intl. Airpt 0855; Dash 8; goûter; fauteuil Columbia*
> *Arrivée Canola Intl. Airpt 1019; passerelle d'embarquement niveau sol, fauteuil* Just Mobility

La meilleure façon d'appliquer cette recommandation serait de pouvoir compter sur l'OAG (*Official Airline Guide*), la base de données continuellement mise à jour où vont puiser, pour la plupart de leurs besoins d'information, les agents de voyage et les sites de réservation sur le Web. Moyennant un investissement infime de temps et d'argent, les sociétés aériennes et les administrations aéroportuaires pourraient fournir aux responsables de l'OAG l'information sur l'embarquement et le rangement des fauteuils roulants, en même temps que l'information qu'ils leur fournissent déjà périodiquement. Les agents de voyage pourraient alors transmettre aux passagers une information à jour sur les procédures d'embarquement et sur le rangement de leur fauteuil roulant selon chaque vol qui effectue le trajet voulu. Les passagers pourraient alors choisir le transporteur et l'itinéraire qui correspondent le mieux à leurs besoins; cela inciterait, jusqu'à un certain point, les sociétés aériennes à se faire concurrence pour offrir les meilleurs choix.

Encadré 2 (suite)

RECOMMANDATION 2 : ***ÉLABORER UNE FORMULE DE FINANCEMENT NOVATRICE, FONDÉE SUR UN PARTENARIAT PUBLIC-PRIVÉ, AFIN D'INSTALLER UNE PASSERELLE D'EMBARQUEMENT NIVEAU SOL À TOUS LES AÉROPORTS OÙ UNE TELLE INSTALLATON EST POSSIBLE D'UN POINT DE VUE ARCHITECTURAL.***

Il y a lieu d'établir un partenariat des secteurs publics et privé (gouvernement fédéral, gouvernements provinciaux, sociétés aériennes et administrations aéroportuaires) pour la mise en place de passerelles d'embarquement niveau sol donnant accès aux petits avions. Car en raison de la demande relativement faible de transport chez les personnes qui se déplacent en fauteuil roulant, le jeu de l'offre et de la demande n'existe pas sur le marché des passerelles d'embarquement niveau sol. Bref, financièrement parlant, les investisseurs ont peu intérêt à engager les sommes nécessaires à la mise en place de passerelles d'embarquement niveau sol, équipements par ailleurs tout à fait légitimes, compte tenu de leurs coûts et avantages sur le plan social. Et un tel «échec du marché» justifie en tous points un financement mixte public-privé des passerelles d'embarquement niveau sol. Il conviendrait de mettre au point immédiatement une formule à l'intérieur de laquelle seraient prévues des négociations sur le cofinancement par les parties intéressées (gouvernements fédéral et provinciaux, administrations aéroportuaires, sociétés aériennes) d'au moins une passerelle d'embarquement niveau sol à chaque aéroport canadien.

RECOMMANDATION 3 : ***FAIRE APPEL À LA COOPÉRATION DES SECTEURS PUBLIC ET PRIVÉ POUR FINANCER ET ENTREPRENDRE L'AMÉNAGEMENT DE L'INTÉRIEUR DES PETITS AVIONS DE FAÇON À EN ACCROÎTRE L'ACCESSIBILITÉ***

La recherche sur les véhicules autres que les avions (voitures de chemin de fer et autobus) révèle qu'il est possible d'aménager l'intérieur des véhicules de façon qu'ils soient accessibles aux personnes handicapées, sans réduire le nombre de places (lorsque aucun fauteuil roulant ne se trouve à bord). Un programme de recherche et de développement financé conjointement par les secteurs public et privé devrait être lancé pour l'application de ces principes de conception à l'éventail le plus large possible des petits avions utilisés dans le transport aérien à horaire fixe.

RECOMMANDATION 1 : *FOURNIR AUX PASSAGERS TOUTE L'INFORMATION DONT ILS ONT BESOIN POUR FAIRE LES MEILLEURS CHOIX ET FAVORISER AINSI LA CONCURRENCE ENTRE FOURNISSEURS.*

L'expérience acquise au cours de la présente étude a révélé qu'une tierce partie, en l'occurrence une firme de consultants, n'a pas suffisamment d'ascendant sur les populations cibles (sociétés aériennes et administrations aéroportuaires) pour les motiver à participer à une enquête et à remplir un questionnaire détaillé. D'où la probabilité qu'une base de données fondée sur les réponses à une telle enquête comporte des lacunes ou des données douteuses.

Néanmoins, l'information sur les équipements d'embarquement disponibles et les procédures d'embarquement doit être publique et doit pouvoir être consultée aux points de vente des billets d'avion. Quant aux données sur les modalités d'embarquement et de rangement des fauteuils roulants aux aéroports de départ, d'arrivée et de correspondance, elles devraient s'afficher automatiquement, en même temps que les autres renseignements sur les vols réguliers. Cette information devrait apparaître, encore là automatiquement, sur l'itinéraire de vol de chaque passager. Voici un exemple :

> *Air Mobius Vol 3035;*
> *Départ Granola Intl. Airpt 0855; Dash 8; goûter; fauteuil Columbia*
> *Arrivée Canola Intl. Airpt 1019; passerelle d'embarquement niveau sol, fauteuil* Just Mobility

Le fait de relier l'information sur l'équipement d'embarquement aux autres données contenues dans la base de données de l'OAG constitue une façon simple d'encourager les transporteurs aériens à coopérer et à fournir l'information demandée. L'OAG est une base de données continuellement mise à jour où vont puiser, pour la plupart de leurs besoins d'information, les agents de voyage et les sites de réservation sur le Web. Moyennant des investissements supplémentaires minimes en temps et en argent, les sociétés aériennes et les administrations aéroportuaires pourraient fournir aux responsables de l'OAG l'information sur l'embarquement et le rangement des fauteuils roulants, en même temps que l'information qu'ils leur fournissent déjà périodiquement. Les agents de voyage pourraient alors transmettre aux passagers une information à jour sur les procédures d'embarquement et sur le rangement de leur fauteuil roulant selon chaque vol qui effectue le trajet voulu. Et les passagers pourraient choisir le transporteur et l'itinéraire qui

correspondent le mieux à leurs besoins; cela inciterait, jusqu'à un certain point, les sociétés aériennes à se faire concurrence pour offrir les meilleurs choix.

De plus, une base de données sur les équipements et les procédures d'embarquement ainsi constituée représenterait un outil dynamique et complet qui pourrait se révéler grandement utile aux décideurs. L'application de cette recommandation ne coûterait rien au gouvernement.

RECOMMANDATION 2 : *ÉLABORER UNE FORMULE DE FINANCEMENT NOVATRICE, FONDÉE SUR UN PARTENARIAT PUBLIC-PRIVÉ, AFIN D'INSTALLER UNE PASSERELLE D'EMBARQUEMENT NIVEAU SOL À TOUS LES AÉROPORTS OÙ UNE TELLE INSTALLATION EST POSSIBLE D'UN POINT DE VUE ARCHITECTURAL.*

La présente étude a démontré que pour des raisons d'exiguïté, l'accès au Beechcraft 1900D et au Metroliner est difficile, voire impossible en fauteuil d'embarquement ordinaire. Pour faire monter à bord de ces avions un passager qui se déplace en fauteuil roulant, il faut un appareil de levage et un fauteuil de transfert *Just Mobility*, très étroit.

L'étude a également montré que monter et descendre un escalier d'avion en transportant un passager à la force des bras représente des dangers tant pour le passager que pour les préposés qui le transportent. Cette manœuvre nécessite en effet une grande force musculaire de la part des préposés et un certain sens de l'équilibre de la part du passager. Cette manœuvre comporte un risque inhérent de blessure tant pour le passager que pour les préposés. Pour des raisons de sécurité, il convient donc d'éviter autant que possible de transporter le passager dans un fauteuil à la force des bras.

Ainsi, la présence à tous les aéroports de passerelles d'embarquement niveau sol ou d'appareils de levage appropriés garantirait un accès sûr aux petits avions.

Par ailleurs, l'embarquement et, subsidiairement, la fourniture de l'équipement d'embarquement incombent aux transporteurs aériens. Or, le financement de tels équipements risque de poser problème : il n'est pas sûr que les petits transporteurs soient capables d'acheter eux-mêmes les appareils de levage et les passerelles nécessaires pour équiper tous les aéroports qu'ils desservent. De plus, le marché de la fourniture de services de transport aérien accessibles est trop restreint – selon le jeu de l'offre et de la demande – pour promouvoir

l'achat d'équipements d'embarquement efficaces par les transporteurs aériens capables d'envisager de telles dépenses.

Il y a néanmoins un «intérêt public», ou un avantage social, à doter la plupart des aéroports d'un équipement d'embarquement efficace, comme une passerelle d'embarquement niveau sol. Les économistes utilisent l'expression «échec du marché» pour désigner cette fracture entre les intérêts financiers et les intérêts sociaux. La solution à ce problème est la fourniture du bien ou du service par le gouvernement. Dans le cas présent, l'échec du marché justifie en tous points un financement mixte public-privé des passerelles d'embarquement niveau sol. Il conviendrait de mettre au point immédiatement une formule à l'intérieur de laquelle seraient prévues des négociations sur le cofinancement par les parties intéressées (gouvernements fédéral et provinciaux, administrations aéroportuaires, sociétés aériennes) d'au moins une passerelle d'embarquement niveau sol à chaque aéroport canadien.

RECOMMANDATION 3 : *FAIRE APPEL À LA COOPÉRATION DES SECTEURS PUBLIC ET PRIVÉ POUR FINANCER ET ENTREPRENDRE L'AMÉNAGEMENT DE L'INTÉRIEUR DES PETITS AVIONS DE FAÇON À EN ACCROÎTRE L'ACCESSIBILITÉ.*

Aujourd'hui, tous les petits avions, quel qu'en soit le type, ont un vestibule d'accueil très exigu et un couloir très étroit. Il est donc impossible de monter à bord de ces avions en fauteuil ordinaire : il faut nécessairement utiliser un fauteuil d'embarquement ou de transfert étroit. Or, les démonstrations d'embarquements réels ont montré que même en fauteuil étroit, l'accès peut être difficile, sinon impossible. Il y a donc lieu d'envisager la possibilité d'améliorer l'aménagement intérieur des avions. Idéalement, la cabine devrait comporter un certain nombre de sièges permettant un transfert direct depuis un fauteuil roulant ordinaire. À tout le moins, l'avion devrait être facilement accessible à tous les fauteuils d'embarquement couramment utilisés dans l'industrie.

Il existe d'ores et déjà des options d'aménagement propres à accroître l'accessibilité. On pourrait privilégier celles qui n'entraînent pas de réduction du nombre total de sièges. Ainsi, la recherche sur les véhicules autres que les avions (voitures de chemin de fer et autobus) révèle qu'il est possible d'aménager l'intérieur des véhicules de façon qu'ils soient accessibles aux personnes handicapées, sans réduire le nombre de places (lorsque aucun fauteuil roulant n'est embarqué). Un programme de recherche et de

développement financé conjointement par les secteurs public et privé devrait être lancé pour l'application de ces principes de conception à l'éventail le plus large possible des petits avions utilisés dans le transport aérien à horaire fixe.

RECOMMANDATION 4 : *REPENSER LES SIÈGES D'AVION DE FAÇON QUE LES ACCOUDOIRS DES SIÈGES DE LA PREMIÈRE RANGÉE SOIENT MOBILES*

Dans les types d'avions étudiés, les accoudoirs des sièges de la rangée deux et des rangées suivantes sont relevables, mais pas ceux de la première rangée. (L'accoudoir sert habituellement au rangement des plateaux amovibles.) Or, il est beaucoup plus difficile pour le passager de passer du fauteuil d'embarquement au siège de l'avion lorsque l'accoudoir est fixe que lorsqu'on peut le relever. La première rangée offre aussi davantage d'espace pour les jambes et pour la manœuvre du fauteuil d'embarquement. Bien entendu, nul n'est besoin alors de pousser le passager en fauteuil d'embarquement dans le couloir étroit de l'avion. C'est pourquoi, dans toute la mesure du possible, il y a lieu de réserver les sièges de la première rangée aux passagers à mobilité réduite.

RECOMMANDATION 5 : *ÉLABORER DES NORMES APPLICABLES À LA CONCEPTION DES FAUTEUILS D'EMBARQUEMENT QUI TIENNENT COMPTE DES BESOINS ERGONOMIQUES DES PASSAGERS ET QUI FACILITENT LA TÂCHE AU PERSONNEL DU TRANSPORTEUR*

À l'heure actuelle, il n'existe pas de norme de conception des fauteuils d'embarquement, mais seulement des lignes directrices mises au point par l'ATBLB, aux États-Unis, il y a une dizaines d'années. Les passagers qui ont besoin d'aide pour l'embarquement doivent souvent passer beaucoup de temps dans un fauteuil d'embarquement ou de transfert. Il est donc essentiel de doter ces fauteuils de caractéristiques ergonomiques propres à assurer le confort et la sécurité du passager. De plus, il importe de concevoir des fauteuils qui soient le plus simples possible à manœuvrer pour les préposés, qui exigent le minimum de force et entraînent le minimum de contact physique entre le passager et le préposé. La présente étude a permis de constater que certains fauteuils sont mieux que les autres à ces égards. C'est le cas en particulier du fauteuil *Columbia*, qui est l'un des mieux conçus, et de beaucoup supérieur au fauteuil *Washington*. Il y a donc lieu de se débarrasser graduellement des fauteuils les moins confortables ou de les améliorer.

RECOMMANDATION 6 : *RÉSERVER LES SIÈGES DE LA PREMIÈRE RANGÉE AUX PASSAGERS À MOBILITÉ RÉDUITE*

Les démonstrations d'embarquements réels menées dans le cadre de l'étude ont révélé qu'il est beaucoup plus facile d'installer le passager à mobilité réduite dans la première rangée que dans la deuxième rangée et les suivantes. La première rangée a aussi l'avantage d'offrir davantage d'espace pour les jambes, ce qui contribue au confort de passagers qui ont certain types de handicaps. À l'heure actuelle, la réglementation sur la sécurité interdit d'assigner à des passagers à mobilité réduite un siège de la première rangée près de la porte d'entrée. Mais les sièges de la première rangée du côté opposé à la porte d'entrée peuvent être assignés à des passagers à mobilité réduite. On pourrait donc réserver ces sièges à ce groupe de passagers, sans qu'il soit nécessaire de modifier la réglementation.

RECOMMANDATION 7 : *FINANCER À L'AIDE DE FONDS PUBLICS UNE ÉTUDE DE FAISABILITÉ SUR UN SYSTÈME D'EMBARQUEMENT INTÉGRÉ AU PETIT AVION QUI SERAIT UTILISÉ AUX AÉROPORTS OÙ IL EST IMPOSSIBLE DE METTRE EN PLACE UNE PASSERELLE D'EMBARQUEMENT NIVEAU SOL*

Aujourd'hui, beaucoup d'autobus urbains et de trains de Via Rail sont équipés d'élévateurs embarqués. Si on dotait les avions de dispositifs semblables, l'embarquement des passagers handicapés ne saurait poser problème à aucun des aéroports desservis par ces avions. Ce mécanisme d'embarquement serait plus efficace qu'un fauteuil roulant et représenterait une solution de rechange économique aux plates-formes élévatrices standard. Les élévateurs embarqués pourraient ainsi constituer la solution la plus économique pour les transporteurs aériens et permettraient d'uniformiser la procédure d'embarquement, à tous les aéroports et chez tous les transporteurs.

RECOMMANDATION 8 : *ÉTABLIR DES LIGNES DIRECTRICES CONCERNANT LES TRANSFERTS ET LES AUTRES DÉTAILS DE LA PROCÉDURE D'EMBARQUEMENT*

À l'heure actuelle, il n'existe pas, au Canada, de politique ou de ligne directrice précise sur l'accessibilité des petits avions ni sur la procédure d'embarquement comme telle. Les transporteurs aériens fournissent les services nécessaires pour respecter le principe de la non-discrimination fondée sur un handicap et pour éviter de créer des obstacles indus aux possibilités de

déplacement des personnes atteintes de déficience. Un ensemble de normes ou de lignes directrices garantirait un traitement digne et uniforme des passagers par tous les transporteurs aériens, à tous les aéroports.

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1: INTRODUCTION AND ORGANIZATION OF THE REPORT

This report presents the results of a survey of manufacturers of boarding devices for small aircraft and surveys of airports and air carriers on the availability and use of such equipment in Canadian airports. It also outlines recommendations that would improve accessibility of small aircraft to passengers with a disability. (Small aircraft considered in this study are aircraft with 19 to 60 passenger seats.) This section briefly discusses the problem of boarding aircraft by passengers with a disability, states what the study is expected to achieve, and explains the organization of the remaining part of the report.

1.1 Background

Access to small aircraft can be a great challenge to passengers using a mobility aid such as a wheelchair, scooter, or walker. In recent years this problem has become more and more urgent. The reasons include an increase in the number of small aircraft and trips on small aircraft, ageing population and increase in the number of people with mobility impairments, as well as a growing perception that people with disabilities need to be included in the general mainstream of society.

An important part of the Canadian Transportation Agency's (CTA) mandate is to ensure that persons with a disability can obtain access to the federally regulated transportation system without encountering undue obstacles. A number of types of boarding equipment do exist but their suitability and compatibility with certain aircraft types may be a problem.

One aspect of CTA's mandate is review and adjudication of disability-related complaints filed with CTA by travellers.[1] CTA investigates the case, contacting the airline to obtain its comments regarding the incident and the passenger to obtain his or her response to the explanation provided by the airline. In cases where CTA determines that there is an undue obstacle, it may order corrective actions to remove the obstacle or order compensation for expenses incurred by the traveller, or both.

[1] CTA has issued an Accessibility Complaint Guide, which explains how to file a complaint and what information should be provided. The Guide also provides suggestions that may help if an undue obstacle is encountered when travelling.

Table 1-1 shows the number of complaints dealt with by CTA, and a list of issues of these complaints broken down by certain common categories.[2]

Table 1-1: Number of Complaints Dealt with by the Canadian Transportation Agency

COMPLAINT TYPE	1996	1997	1998	1999
Carried over from previous year (awaiting decision and follow-up analysis)	17	21	28	N/A
New complaints	8	31	39	70
Resolved complaints (i.e. decisions)	9	45	49	51

Source: Compiled from Annual Reports of the Canadian Transportation Agency for years from 1996 to 1999

Table 1-2: Issues of Complaints (Percent of Cases)

ISSUES OF COMPLAINTS	1996	1997	1998	1999
Breakdown in communication		11.8	5	7
Personal awareness	18	8.3	16	8
Seating accommodation	18	18.5	14	14
Facilities		10.7		
Equipment		11.8	11	1
Terminal accessibility		11.8	13	3
Service deficiencies	37	26.8	25	24
Refusal of service or conditions of acceptance	27	0.3	9	8

Source: Compiled from Annual Reports of the Canadian Transportation Agency for years from 1996 to 1999

As Table 1-1 indicates, the number of complaints increased considerably from 1996 to 1997 and from 1998 to 1999. It is believed that this is due to more

[2] The information on complaints is not broken down by mode of transportation, but the vast majority of them are related to travel by air.

frequent travelling by passengers with a disability rather than deteriorating service. The number of complaints received specifically in relation to small aircraft is very small, in the range of a few cases per year.

As Table 1-2 indicates, the issues of complaints range from breakdowns in communication and personnel awareness to outright refusal of service.

1.2 Purpose of the Study

This study examined boarding equipment and procedures available to persons with a disability on small passenger aircraft (19 to 60 passenger seats) in scheduled service at Canadian airports. Information was collected and analyzed in relation to the availability of boarding devices, their use, cost, performance, and compatibility with small aircraft.

1.3 Organization of the Report

Section 2 of this report explains the methodology employed in this study and the following sections present the results of the analysis involved in each methodological component. Section 3 presents an overview of regulatory environment in relation to small aircraft in Canada and the US. Section 4 analyzes the use of small aircraft in Canada. Sections 5 and 6 present the results of surveys and data analysis on operational characteristics, availability in airports and use of boarding devices. Section 7 reports the results from aircraft inspections. Section 8 presents the results of boarding demonstrations on selected aircraft types. Finally, Section 9 summarizes the findings, while Section 10 concludes and offers recommendations.

Appendix A discusses the concept and the design architecture of a relational database on small aircraft and boarding devices, and Appendix B presents the results of a workshop with stakeholders. Appendices C, D and E contain the survey questionnaires that were distributed to manufacturers of boarding devices, air carriers and airports, respectively. Appendix F provides the minutes from the stakeholder workshop. Appendix G presents photographs of typical boarding equipment. Appendix H provides details of small aircraft interior layouts, and Appendix I presents full reports from aircraft inspections and demonstrations.

2: METHODOLOGY

For the purpose of this analysis, the term *small aircraft* is defined as aircraft with 19 to 60 passenger seats.

The methodology employed in this study involved the following major components:

1. Review of current regulatory environment in relation to small aircraft access in Canada and the United States;
2. Analysis of the OAG (Official Airline Guide) data on flight schedules for aircraft size of 19 to 60 passenger seats (for a specific selected period of time);
3. Survey and evaluation of "level-change" equipment for small aircraft, and boarding procedures used to board passengers with mobility impairments, including:
    - Survey of equipment manufacturers on devices manufactured, their operational characteristics and compatibility with aircraft,
    - Survey of airports on availability, usage, and performance of equipment,
    - Survey of air carriers on ownership, usage, and performance of equipment;
4. Workshop with stakeholders on survey results and effectiveness of boarding devices;
5. Identification and evaluation of boarding and transfer chairs;
6. Analysis of passenger cabin layout of selected aircraft types most commonly used in scheduled service in Canada;
7. Live boarding and disembarkation demonstrations on selected aircraft types most commonly used in scheduled service in Canada.

This methodology achieved study objectives in the following way:

The review of regulatory environment allowed the establishment of the underlying regulatory philosophy and legal context within which airlines and airports operate.

Analysis of an OAG database sample identified small aircraft used in Canada and the pattern of use by various air carriers. This in turn helped identify the largest air carriers using small aircraft, their fleet composition, and aircraft types most suitable for a comprehensive study.

Survey instruments allowed the collection of more direct information on boarding devices available on the market and in airports. Survey information as well as information from OAG made it then possible to design a relational database with baseline information on the availability of boarding devices, their compatibility and other operational information.

The workshop with stakeholders allowed inclusion of input from stakeholders (such as users of wheelchairs who frequently travel by air).

Identification and analysis of boarding and transfer chairs allowed for the evaluation of chairs in various terms, including compatibility with various aircraft types.

The analysis of aircraft cabin layout determined sections of the aircraft where space clearance is tight and where the problem of aisle and seating accessibility to passengers using a mobility aid may arise. In other words, this methodological component was intended to identify aircraft where moving a passenger with a mobility impairment from the aircraft door to his/her seat may be difficult, thus restricting access to these aircraft types, or making these aircraft types *de facto* inaccessible.

Live boarding demonstrations confirmed information collected in the earlier step by testing how boarding and transfer chairs work in practice and how passengers using a mobility aid can access the aircraft and their seat on board the aircraft.

The project was carried out in two phases:

- Phase I, or main phase (from April 2000 to October 2001), included a review of the regulatory environment, collection and analysis of OAG

database on small aircraft use in Canada, a survey of manufacturers, airports and air carriers, an analysis of collected survey information, and a workshop with stakeholders.

- Phase II, or extension of the main phase (from February 2002 to December 2002), included an update on the pattern of small aircraft use in Canada, a detailed evaluation of boarding and transfer chairs, an analysis of interior cabin layout and access of selected aircraft types, and boarding demonstrations.

2.1 Review of Current Regulatory Environment in Relation to Small Aircraft

The following documents were identified and reviewed to determine the nature of specific provisions and their regulatory status.

For Canada:

- Code of Practice for Aircraft Accessibility for Persons with Disabilities;
- Personnel Training for the Assistance of Persons with Disabilities; and
- Part VII, Section 145 of Air Transportation Regulations.

For the United States:

- Air Carrier Access Act; and
- 14 Title of the Code of Federal Regulations Part 382 (14 CFR).

2.2 OAG Data on Flight Schedules

OAG is the world's leading independent provider of travel information products and services. It is probably best known for its airline and flight data, which are distributed throughout the world to travel agents, corporations, airlines and airports. OAG also prepares customized databases of flight schedules and other related data for research, planning and marketing purposes.

For the purpose of this study, in the first phase of the project HLB requested a database of flight schedules for the period from April 1 to 15, 2000, for aircraft with capacity of 19 to 60 seats, with departure or arrival airports in Canada. This produced 5563 flight records (each of which may involve several

departures/arrivals over the time period), each containing several fields such as departure time, arrival time, departure airport, arrival airport, airline, flight number, aircraft, and seat capacity. The vast majority of the flights had both the departure and arrival airports in Canada. The remaining flights were all, except for one, cross-border flights between Canada and the US.

This database allows identification of the small aircraft types used in Canada, the airports served by various small aircraft, and the airlines using small aircraft.

In the second phase of the project, HLB requested another sample database of flight schedules for the period from February 4 to 10, 2002. This period can again be considered a typical "shoulder period" covering the weekdays from Monday to Sunday and thus presenting a typical picture of services on small aircraft.

This data sample was used to confirm the aircraft types most frequently used in Canada, the largest carriers using small aircraft and their small aircraft fleet composition.

This information was then used to select aircraft types most suitable for further detailed study on interior aircraft cabin layout and aisle and seating accessibility. The aircraft types were selected according to the following criteria:

1. Aircraft types flown by the five top air carriers;
2. Aircraft types most frequently used in Canada, and
3. Aircraft types serving airports in Ottawa and/or Dorval.

The selection criteria reflected both the purpose of the study as well as operational constraints, i.e. easy access to aircraft for inspection and demonstrations.

2.3 Survey Instruments

Three survey instruments were developed for this study:

- Survey of manufacturers of boarding devices for small aircraft;

- Survey of airports on boarding procedures and boarding devices used to board passengers with mobility impairments on small aircraft; and
- Survey of air carriers on boarding procedures and boarding devices used to board passengers with mobility impairments.

Each survey was tested in the Ottawa area before actual distribution.

Below we briefly describe the design of the survey instruments, their distribution and returns. Appendices C, D, and E contain the actual questionnaires. Chapters 5 and 6 discuss the results.

2.3.1 Survey of Manufacturers

The survey asked the manufacturers to identify the equipment they manufacture and provide the following information:

- Basic engineering characteristics such as size, whether the lifting mechanism is motorized, types of safety features;
- Performance according to criteria such as reliability in extreme temperatures, types of wheelchairs that can be lifted;
- Operational features such as number of persons and physical effort level required to operate the device;
- Recommended boarding protocol;
- Cost and maintenance information; and
- Compatibility with various small aircraft (i.e. whether a device is compatible).

On the basis of previous studies and additional research, 31 manufacturers of boarding devices were identified, including companies based in Canada, the United States, and overseas. A copy of the survey was sent to each of those manufacturers. Nine surveys were returned. Follow-up research determined that 14 out of the original 31 manufacturers are either no longer in business or had merged with other companies, and two manufacturers are no longer manufacturing boarding equipment for small aircraft. This implies that currently there are about 15 manufacturers of boarding equipment for small aircraft in the market. Thus the survey success rate was about 60 percent, and

devices accounted for by surveys and additional research amounted to 90 percent.

2.3.2 Survey of Air Carriers

The survey asked air carriers to identify the type of devices they use to board passengers with mobility impairments on small aircraft and provide operational and performance information in relation to this equipment such as:

- Frequency with which the devices were deployed;
- Ownership status of the equipment;
- Purchase price and other operational costs; and
- Performance in terms of certain criteria such as ease of operation, maintenance required, staff and passenger safety, passenger dignity.

The survey also asked to identify and characterize boarding protocols as well as provide information of stowage capacity of various small aircraft types.

Since boarding procedures may differ from airport to airport, the survey had to be conducted at the airport level by station managers of each airline. Establishing airport-level contact information for each Canadian air carrier turned out to be a challenging task as some airlines were not co-operative. The Air Transportation Association of Canada (ATAC) was approached and asked for help in survey distribution through their accessibility committee.

Altogether, surveys were distributed to Air Canada and 20 other air carriers. Forty-nine surveys were returned to HLB. Unfortunately, repeated reminders about the survey sent to air carriers by ATAC were not effective. Additional information on the use of boarding devices in various airports came from the survey of airports. Twenty-nine completed surveys of airports were returned. Altogether, surveys of airports and air carriers covered 62 airports. (For some airports, responses from two air carriers, or both from an air carrier and the airport authority were obtained.)

While the number and distribution of survey responses from airlines (small, medium-sized, and large airports) were sufficient to judge the findings reported here as representative, the response rate was not high enough to interpret the results using benchmark criteria of statistical significance.

2.3.3 Survey of Airports

The survey questionnaire for airports was almost identical to that of questionnaire for air carriers, except that questions specifically related to aircraft features, such as stowage capacity, were omitted from the survey of airports.

The survey was mailed out to 299 airports using Transport Canada's database of airport contact information. Eighty-nine surveys were returned to HLB.

The response rate, about 30 percent, was thus low. However, the returned surveys, as well as telephone calls from several airport managers, indicated that the vast majority of airports are not involved in boarding procedures, do not own boarding equipment, and thus cannot provide information asked in the questionnaire. Sixty of the returned surveys specifically indicated that the airport does not have access to boarding equipment for small aircraft (Question 1 in the airport questionnaire). A larger response rate would thus not have substantially increased the amount of information on the boarding situation in Canadian airports.

The survey results on the use of boarding equipment presented in this report thus came from 29 completed surveys of airports and 49 completed surveys of air carriers, and cover 62 airports.

2.3.4 Relational Database with Information on Small Aircraft and Boarding Devices for Small Aircraft

The concept of a relational database with information on small aircraft and the availability of boarding devices was developed to facilitate the analysis of the state of small aircraft boarding by persons with a disability in Canada. The survey instruments were designed in such a way as to collect comprehensive information on boarding devices, small aircraft, and details of current boarding practices.

However, the survey approach to populate an effective database turned out to be an exercise with several constraints.

First, a relatively low survey return rate demonstrated that a third party, a consulting firm, cannot exert enough pressure on the target populations of survey respondents to motivate them to participate in a survey and fill out a survey questionnaire. Faced with time constraints and rising costs, companies

give a low priority to surveys or are outright unco-operative. A database resulting from a survey administered by a consultant will thus likely have several gaps or uncertain information.

Second, the use of surveys provides only a "snapshot" of the market where small aircraft operate. Changes to particular flight details, changes in the carrier makeup itself, and other unanticipated departures from the initial snapshot mean that results quickly become obsolete.

These limitations prompted HLB to develop an alternative approach to establishing a small aircraft database. This approach is two-pronged, reflecting the differing needs of passengers and policy makers.

In order to meet the detailed information needs of passengers regarding boarding device/procedure availability, a dynamic and widely accessible solution is proposed. The most cost-effective means to create a sufficiently dynamic database requires that the OAG collect flight-by-flight information regarding boarding devices and/or procedures. This information would then be widely accessible by carriers, airports, travel agents and passengers.

In the second, simultaneous approach, we create a database that accesses the information in the OAG and combines it with other key data elements collected through interviews and surveys. Boarding device manufacturers, carrier boarding policy-makers, aircraft manufacturers, groups representing persons with disabilities and other stakeholder groups would be involved in an ongoing basis to maintain up-to-date specifications on all qualitative elements of small aircraft boarding. The database then becomes an effective, user-friendly and flexible tool for policy analysis.

2.4 Workshop with Stakeholders

The purpose of the workshop with stakeholders was to seek comments on effectiveness of various boarding devices and desirable policy directions in light of survey findings.

The participants of the workshop included persons using a wheelchair who frequently travel by air, as well as representatives of the Canadian Transportation Agency. Representatives of the Transportation Development Centre of Transport Canada sat in on the meeting as observers.

HLB presented the survey results focussing on the assessment of effectiveness and performance. Participants were encouraged to express their views and opinions on boarding equipment currently used in Canada, in particular their effectiveness. These comments were then used in developing policy recommendations.

2.5 Identification and Evaluation of Boarding and Transfer Chairs

Using the survey results on boarding equipment, the most commonly used boarding and transfer chairs were identified.

The survey results as well as additional research were used to determine detailed features of boarding chairs such as specific dimensions, and safety features.

This provided the basis for an evaluation of boarding chairs in terms of comfort and safety for the passenger, ease of operation, and compatibility with various small aircraft types.

2.6 Analysis of Passenger Cabin Layout of Selected Small Aircraft

Drawings and schematics of aircraft, information from airlines and manufacturers, and on-site aircraft inspections were used to collect data on various aircraft features, including:

- Number of seats and seat layout;
- Rows with fixed armrests and rows with pivoting aisle armrests;
- Aisle width;
- Vestibule width, length, and height;
- Seat height;
- Availability of accessible washroom; and
- Size of baggage compartment door.

This information provided preliminary conclusions regarding seat and aisle accessibility, other tight spaces, as well as the possibility of storing mobility aids in the baggage compartment.

2.7 Live Boarding Demonstrations

Boarding demonstrations involved a subject using a mobility aid being boarded onto a small aircraft by trained air carrier agents and according to standard boarding procedures. Thus, the boarding exercise included:

- Transfer of the passenger from his/her own chair to the carrier boarding chair,
- Carrying of the passenger in the boarding chair up the stairs of the small aircraft,
- Bringing the passenger in the boarding chair to his/her seat; and
- Transferring the passenger from the boarding chair to his/her seat.

Disembarkation was carried out in reverse order. The entire exercise was both videotaped and photographed.

This component of the methodology allowed for the demonstration of how the boarding procedure – in particular moving the passenger from aircraft door to his/her seat in aircraft – works in practice on various aircraft types commonly used in air service, and for documentation of the details of the procedure, including transfer techniques, satisfaction and comfort of the passenger, ease of operation for carrier agents, and any expected or unexpected difficulties.

3: CURRENT POLICY AND REGULATORY ENVIRONMENT

This section discusses policy and regulatory environment in relation to small aircraft. Section 3.1 discusses Canadian policies and regulations and Section 3.2 discusses US policies and regulations.

3.1 Canada

3.1.1 Code of Practice 'Aircraft Accessibility for Persons with a Disability'

The Code is a set of standards suggested by the Canadian Transportation Agency pertaining to various accessibility features that air carriers have agreed to provide. However, the Code is voluntary in nature and does not entail a legal obligation. The Code applies to aircraft with 30 or more passenger seats. Similar standards for smaller aircraft have not been adopted. However, the CTA can still investigate complaints in relation to aircraft with fewer than 30 seats based on the notion of undue obstacles to air travel.

The accessibility features discussed in the Code refer mainly to various design features such as boarding stairs, storage space for wheelchairs, armrests, and washrooms. Below is a brief summary of recommended standards.

3.1.1.1 Integrated boarding stairs

Integrated boarding stairs on an aircraft should have uniform riser heights and uniform tread depths. The tread surfaces of the stairs should be firm and non-slippery and should not create glare. A contrasting colour strip that runs the full width of the step and is readily apparent from both directions of travel should mark the top outer edge of each step. Handrails should be provided on both sides. Handrails on integrated boarding stairs should be sturdy, rounded, smooth and slip-resistant. They should have an exterior diameter that permits easy grasping and not have any obstructions that could break a handhold. Handrails should be colour contrasted from their surrounding area or marked with a contrasting colour strip that runs the full length of the handrail.

3.1.1.2 Storage space for passenger-owned wheelchair

If the configuration of an aircraft with 100 or more passenger seats permits it, the aircraft should have storage space in the passenger cabin to carry at least one manually operated folding or collapsible wheelchair owned by a passenger.

3.1.1.3 Armrests

With respect to a newly manufactured aircraft that is ordered, purchased or leased by an air carrier, at least 50 percent of the aisle armrests on the passenger aisle seats in the aircraft should be movable. If possible, the passenger seats with movable aisle armrests should be evenly distributed throughout the aircraft.

For existing passenger seats in an aircraft that are being replaced with newly manufactured passenger seats, the aisle armrests on the newly manufactured passenger seats should be movable. This practice should continue until such time as the above criteria concerning 50 percent movable armrests and even distribution are satisfied.

3.1.1.4 Washrooms

With respect to a newly manufactured aircraft with more than one aisle that is ordered, purchased or leased by an air carrier to be used on or after January 1, 1999, that aircraft should have at least one washroom that is accessible to persons with disabilities, including persons in an onboard wheelchair.

For all aircraft with more than one aisle other than newly manufactured aircraft, it is expected that, by January 1, 2002, those aircraft will have been retrofitted so that at least one washroom is accessible to persons with disabilities, including persons in an onboard wheelchair.

With respect to a newly manufactured aircraft with one aisle that is ordered, purchased or leased by an air carrier to be used on or after January 1, 1999, that aircraft should have at least one washroom that is accessible to persons with disabilities, with the exception of persons in an onboard wheelchair.

For all aircraft with one aisle other than newly manufactured aircraft, it is expected that, by January 1, 2002, those aircraft will have been retrofitted so that at least one washroom is accessible to persons with disabilities, with the exception of persons in an onboard wheelchair.

If an air carrier operates an aircraft with a washroom able to accommodate a person in an on-board wheelchair, the air carrier should carry at all times at least one on-board wheelchair on that aircraft.

3.1.2 Personnel Training for the Assistance of Persons with Disabilities Regulations

The Personnel Training for the Assistance of Persons with Disabilities Regulations have been in effect since January 1995.[3] They apply to marine, rail and air carriers, and terminal operators, but not to carriers who provide services in air terminals with fewer than 10,000 enplanements per year.

Air carriers and air terminal operators, with the exception of small air terminal operators,[4] are required to ensure that their employees and contractors who provide different types of transportation-related services to persons with a disability are properly trained, know the carrier's or terminal operator's policies and procedures with respect to passengers with a disability, and have received general sensitivity training with respect to the needs of person with a disability.

Carriers' employees and contractors required to provide physical assistance have to receive a level of training to be able to:

- Assist persons using a mobility aid;
- Properly transfer a person to/from a mobility aid;
- Guide and orient a person who is blind or visually impaired; and
- Assist a person who has balance, agility or co-ordination difficulties.

Carriers also have to ensure that an appropriate level of training is provided to their employees and contractors who are required to handle mobility aids. They must be trained with respect to different types of mobility aids, in particular their disassembling, packing, stowing, and assembling.

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[3] The full title of the regulations is Regulations Respecting the Training of Personnel Employed in Transportation-Related Facilities.

[4] Small air terminals are those with fewer than 10,000 enplaned and deplaned passengers in each of the two preceding years. Small air carriers are defined as those, which (i) provide service only to small terminals, (ii) whose gross annual revenue was less than $500,000 in either of the two preceding calendar years, or (iii) whose operations are limited to servicing the needs of lodge operations.

All personnel required to be trained have to complete their initial training within 60 days after beginning work. They also have to receive periodic refresher training sessions.

Carriers and terminal operators have to keep a copy of their training program available for reference by the general public.

3.1.3 Part VII of Air Transportation Regulations (Section 145)

The Canada Transportation Act provides that the CTA may, within the approval of the Governor in Council, make regulations for the purpose of eliminating undue obstacles to the mobility of persons with a disability in the transportation network under the legislative authority of Parliament.

Pursuant to Part VII of the Air Transportation Regulations, the CTA regulates the terms and conditions of the domestic carriage of persons with a disability in aircraft of 30 or more passenger seats. However, the CTA can accept complaints regarding travel on smaller aircraft and take corrective actions based on the notion of undue obstacle to air travel. Air carriers are required to offer uniform services to travellers with a disability.

Further issues addressed in the regulations include the following:

- Reservations ahead of time, with a reasonable effort to accommodate passengers without having made the request;
- Assistance:
    - with registration at check-in counter;
    - in proceeding to the boarding area;
    - in boarding and deplaning;
    - in stowing and retrieving baggage;
    - in moving to and from washroom in aircraft (if applicable);
    - in transferring from own wheelchair to carrier chair;
    - in transferring between wheelchair/carrier chair and aircraft seat.

Limited assistance with meals is also to be provided. Carriers are required to carry small mobility aids and service animals without charge and assume full responsibility for mobility aids stowed and carried in the aircraft.

3.2 United States

3.2.1 Background

The legal obligation to provide equal access to air travel to all passengers, or obligation of non-discrimination based on disability, was created by the Federal Aviation Act of 1958. Section 404(b) prohibited "undue or unreasonable preference or advantage to any particular person, port, locality, or description of traffic."[5] However, non-discrimination was understood more as a matter of fair and consistent commercial practices (e.g., ticketing and pricing) than of equal access to air travel.

The Air Carrier Access Act of 1986 (ACAA) prohibits air carriers from discriminating against passengers with a disability on the basis of this disability.[6]

In addition, the ACAA required the Department of Transportation (DOT) to develop new regulations "to ensure non-discriminatory treatment of qualified individuals consistent with safe carriage of all passengers on air carriers". These enforcement rules were issued in 1990.[7] They were especially designed to remove physical barriers encountered by passengers with a disability. While some of these regulations required the design of aircraft to be more accessible, most require airlines to modify their practices to ensure that passengers with a disability will not encounter discrimination.

The DOT regulations were adopted shortly before and as a complement to the Americans with Disabilities Act (ADA) of 1990. Intended to make American society more accessible to people with disabilities, the ADA is a wide-ranging legislation that chiefly addresses issues pertaining to employment, public services, public accommodations and telecommunications.

Despite all these regulations, passengers with disabilities were often denied boarding on small regional aircraft because of their poor accessibility. Because of these problems, in 1996, DOT issued a final rule requiring boarding lifts for aircraft of 19 to 30 seats. Air carriers and airports were also required to work

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[5] Federal Aviation Act, 49 USC 1374.

[6] Air Carrier Access Act, Pub. L. 99-435, 100 Stat. 1080.

[7] US Department of Transportation, Office of the Secretary of Transportation, *14 CFR Part 382, Non-discrimination on the Basis of Handicap in Air Travel*, March 6, 1990.

jointly to make lifts or other boarding devices available.[8] A similar rule applying to aircraft with 31 or more seats was proposed by DOT in 1999.[9]

3.2.2 Requirements of 14 Title of the Code of Federal Regulations Part 382 (14 CFR)

The DOT regulations revising part 382 of 14 CFR represent a major stride forward for people with disabilities. They clearly define the rights of disabled passengers and the obligations of US air carriers. The following is a summary of the requirements for all aircraft and for small aircraft.

3.2.2.1 General provisions

No air carrier may refuse transportation to any person with a disability.

This rule applies only to US air carriers providing commercial air transportation and to US airports. Carriers cannot impose special services not requested by a passenger with a disability, or deny the person the benefit of any regular service available to other passengers. Carriers must also obtain an assurance of compliance from contractors who provide services to passengers.

3.2.2.2 Accessibility of facilities

New aircraft must achieve a higher degree of accessibility than those previously in service. Aircraft in service as of April 5, 1990, are not required to be retrofitted, but any aircraft that undergoes replacement of cabin interior elements, lavatories, or seats must meet these requirements.

Aircraft with 30 or more passenger seats will have movable armrests on at least one half of aisle seats, which will be made available to passengers with mobility impairments. Aircraft with 100 or more passenger seats must have priority space for storing a passenger's folding wheelchair in the cabin. Wide body (twin-aisle) aircraft must have at least one accessible lavatory.

Aircraft with more than 60 passenger seats and an accessible lavatory must have an on-board wheelchair, regardless of when the aircraft was ordered or

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[8] *Federal Register*, "Rules and Regulations", RIN 2105-AB62, November 1, 1996, Volume 61, Number 213, pp. 56409-56425.

[9] *Federal Register*, "Proposed Rules", RIN 2105-AC81, August 26, 1999, Volume 64, Number 165, pp. 46611-46613.

delivered. For flights on aircraft with more than 60 seats that do not have an accessible lavatory, carriers must place an on-board wheelchair on the flight if a passenger with a disability gives the airline 48 hours' notice that he or she can use an inaccessible lavatory but needs an on-board wheelchair to reach the lavatory.

Since 1993, airport facilities owned or operated by carriers must meet the same accessibility standards that apply to federally assisted airport operators.

3.2.2.3 Requirements for services

Carriers may not limit the number of persons with a disability permitted to travel on a given flight. Airlines may exclude anyone from a flight if carrying the person would be inimical to the safety of the flight. If a carrier excludes a person with a disability on a safety basis, the carrier must provide a written explanation of the decision.

Carriers may not require advance notice that a person with a disability is travelling. However, they may require up to 48 hours advance notice and one-hour advance check-in for transportation of an electric wheelchair on an aircraft with fewer than 60 seats and provision of an on-board wheelchair on an aircraft that does not have an accessible lavatory.

Carriers may not require a person with a disability to travel with an attendant, except in very limited circumstances (i.e., people with severe impairments such as passengers travelling in a stretcher or incubator). If a person with a disability and the carrier disagree about the need for an attendant, the airline can require the attendant, but cannot charge for the transportation of the attendant.

Airlines may not keep anyone out of a seat on the basis of disability, or require anyone to sit in a particular seat on the basis of disability, except in order to comply with an FAA safety regulation. FAA's rule on exit row seating allows carriers to place in exit rows only persons who can perform a series of functions necessary in an emergency evacuation. If a service animal cannot be accommodated at the passenger's assigned seat, the carrier shall offer to move the passenger to an alternative seat that can accommodate the animal.

Airlines are required to provide assistance with boarding, deplaning and making connections. Boarding shall be by level entry where possible. Carrier personnel need not hand-carry a person on board a plane with less than 30 seats whose physical limitations preclude the use of existing lifts, boarding chairs, or

other devices. DOT is continuing to seek additional data about lifts for small aircraft. Assistance within the cabin is also required, but does not include personal services (e.g., assistance in eating, with medical services and within the restroom).

Disabled passengers' items stored in the cabin must comply with FAA rules on the stowage of carry-on baggage. Assistive devices do not count against any limit on the number of pieces of carry-on baggage. Wheelchairs and other assistive devices have priority for in-cabin storage space over other passengers' items brought on board at the same airport, if the disabled passenger chooses to pre-board. Wheelchairs and other assistive devices have priority over other items for storage in the baggage compartment.

Carriers must accept battery-powered wheelchairs, including the batteries, which must be packaged according to strict standards.

Carriers may not charge for providing services required by the rule, such as packaging of batteries. However, they may charge for optional services such as the provision of oxygen.

Other provisions concerning services and accommodations address treatment of mobility aids and assistive devices, passenger information, accommodations for persons with hearing impairments, security screening, communicable diseases and medical certificates, and service animals.

3.2.2.4 Administrative provisions

Training is required for carrier and contractor personnel who deal with the travelling public.

The largest airlines (currently about 20) and their US commuter airline affiliates must submit their procedures for complying with the rule to DOT for review.

Carriers must designate complaints resolution officials (CRO) to respond to complaints from passengers and must also respond to written complaints. They shall establish a procedure for resolving written complaints. A DOT enforcement mechanism is also available.

3.2.3 Specific Regulations for Small Aircraft

Carrying passengers with a disability up stairs in a boarding chair is generally viewed as an undesirable way of providing access, for reasons that have to do with the dignity, safety and comfort of these passengers. Consequently, on November 1, 1996, DOT published a final rule requiring air carriers to provide mechanical lifts, ramps, or other suitable devices for boarding assistance to aircraft having 19 to 30 seat capacity at airports with 10,000 or more annual enplanements. Carriers may require one-hour advance check-in for passengers wishing to receive such boarding assistance. Similarly, airports shall ensure that there is an accessible path between the gate and the area from which aircraft are boarded.

As a complement to this final rule, DOT proposed a new regulation in 1999 that would extend these requirements to aircraft with 31 or more seats. The proposal would also require air carriers and airports to work jointly to make lifts or other boarding devices available. According to DOT, incremental costs of the proposal would be negligible since air carriers could use lifts already required by the current rule.

In order to help airports and air carriers meeting these requirements, DOT issued an Advisory Circular (AC) containing performance standards, specifications, and recommendations for the design, construction, and testing of boarding lifts.[10] This AC was developed in coordination with the Canadian General Standards Board so that devices meeting the requirements of either the US or Canadian standards should meet the requirements of the other.[11]

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[10] US Department of Transportation, Federal Aviation Administration, Office of Airport Safety and Standards, *Guide Specification for Lifts Used to Board Airline Passengers with Mobility impairments*, Advisory Circular No. 150/5220-21A, July 26, 1996.

[11] Canadian General Standards Board, *Lifting Systems for Aircraft Boarding of Passengers with Mobility Impairments*, CAN/CGSB-189.1-95.

4: SMALL AIRCRAFT IN CANADA

For the purpose of this project, HLB requested from the OAG (Official Airline Guide) the data on flight schedules for aircraft with capacity of 19 to 60 passengers seats, with departure or arrival airports in Canada. The data covered the period from April 1 to 15, 2000, a period of time that could be considered as a typical two-week period during the "shoulder" flying season.

The database obtained from the OAG contained 5563 flight records (each of which may involve several departures/arrivals over the time period), each containing information on departure time, arrival time, departure airport, arrival airport, airline, flight number, aircraft type, seat capacity, etc. The vast majority of the flights had both the departure and arrival airports in Canada. The remaining flights were all, except for one, cross-border flights between Canada and the US.

We used this database to describe the markets where small aircraft operate, concentrating on aircraft and flight characteristics that may have implications for developing policy standards for boarding this aircraft by disabled individuals.

In the second phase of this project, HLB requested another sample database of flight schedules for the period from February 4 to 10, 2002. This period can again be considered a typical "shoulder period" covering the weekdays from Monday to Sunday and thus presenting a typical picture of services on small aircraft.

The database obtained from OAG in February 2002 contained 2222 flight records, each with similar information on departure time, arrival time, departure airport, arrival airport, aircraft type, seat capacity, flight number, etc. As in the April 200 samples, the vast majority of flights had both the departure and arrival airports in Canada and the other flights were cross-border flights between Canada and the US.

The February 2002 data sample was used to confirm the aircraft types most frequently used in Canada as of early 2002, the largest carriers using small aircraft and their small aircraft fleet composition, and to select aircraft types most suitable for a further detailed study on aircraft passenger cabin layout and aisle and seating accessibility.

Section 4.1 identifies small aircraft used in Canada. We also analyzed compatibility of small aircraft with various mobility aids. Section 4.2 analyzes airports serving small aircraft in terms of their departure volume, region, and aircraft using them. Section 4.3 concentrates on air carriers serving the markets where small aircraft operate in terms of their market share and fleet of aircraft used. Section 4.4 briefly discusses policy implications arising from the earlier analysis. Finally, section 4.5 provides an update on small aircraft use as of early 2002 and selects specific aircraft types for a further more detailed study.

4.1 Use of Small Aircraft in Canada

4.1.1 Types of Small Aircraft Serving the Canadian Market

Table 4-1 shows small aircraft types used in Canada during our sample period, i.e. between April 1 and 15, 2000, ranked by number of departures during that period.

Table 4-1: Small Aircraft Used in Canada

RANK*	AIRCRAFT NAME	SEATS	PERCENTAGE OF FLIGHTS	CUMULATIVE PERCENTAGE OF FLIGHTS
1	De Havilland DHC-8 Dash 8 Series 100	37	23.73	23.73
2	De Havilland DHC-8 Dash 8 Series 300	50	10.28	34.01
3	Beechcraft All Series	up to 19	8.79	42.80
4**	De Havilland DHC-8 Dash 8 All Series	37 or 50	8.41	51.20
5	Fairchild Metroliner	19	8.21	59.41
6	Fokker F28 Fellowship All Series	55	8.07	67.48
7	Beechcraft 1900D	19	8.07	75.55
8	Canadair Regional Jet	50	5.76	81.32
9	De Havilland DHC-6 Twin Otter	19	5.14	86.46

Table 4-1 (continued)

RANK*	AIRCRAFT NAME	SEATS	PERCENTAGE OF FLIGHTS	CUMULATIVE PERCENTAGE OF FLIGHTS
9	De Havilland DHC-6 Twin Otter	19	5.14	86.46
10	BAe Jetstream 31	19	3.22	89.67
11	Saab SF 340	34	3.07	92.75
12	Shorts 360	30	1.78	94.52
13	BAe (HS) 748	42	1.44	95.97
14	Saab SF 340	30	1.34	97.31
15	Embraer RJ135 /RJ145	50	0.58	97.89
16	Embraer EMB-120 Brasilia	30	0.53	98.41
17	BAe (HS) 748	40	0.43	98.85
18	Boeing 727-100C /100QC (Mixed Config)	19	0.34	99.18
19	De Havilland DHC-6 Twin Otter	37	0.29	99.47
20	Fairchild Dornier 328	29	0.29	99.76
21	Fairchild Dornier 328JET	32	0.10	99.86
22	Douglas DC3 / C-47 Dakota (Passenger)	27	0.10	99.95
23	ATR All Series	44	0.05	100.00

NOTES TO TABLE 4-1:

*Aircraft are ranked according to the level of activity, i.e. the percentage of flights flown on that aircraft. A ranking could also have been made on the basis of passenger trips, but these data were not available.

** De Havilland DHC-8 Dash 8 All Series includes both Dash 8-100 and Dash 8-300. This entry refers to those flights for which OAG did not have precise information on the aircraft type (i.e. Dash 8-100 or Dash 8-300).

As Table 4-1 shows, 23 aircraft types were identified. These aircraft range from high wing to low wing, and are powered by either propeller or jet engines. The

service door, which can be located at the front or aft, is combined with a swing-out staircase. The entrance vestibule is small and not suitable for transferring a passenger in a wheelchair. Aisles are very narrow and can only be negotiated with a narrow transfer chair by persons using a wheelchair. Washrooms are not accessible to persons using a wheelchair.

As can be calculated using Table 4-1, seven aircraft types account for almost 75 percent of departures, and various versions of the Dash 8 account for 42 percent of departures. The remaining 16 types account for 25 percent of departures.

4.1.2 Stowage Compatibility of Small Aircraft with Mobility Aids

To determine whether a particular aircraft type can carry certain mobility aids, the following information is required: cargo door size, sill height of cargo door, and cargo volume. This information can then be checked against the size of mobility aids.

The following mobility aids were included in the analysis of stowage capability:

- Manual folded wheelchair;
- Power chair assembled;
- Power chair disassembled; and
- Scooter disassembled.

Manufacturers of 19 different small aircraft were contacted for the information required for our analysis. Ten returns of aircraft inquiries were received. All ten aircraft are physically capable of accommodating the four wheelchair and scooter types. These aircraft types include the following:

- Dash8-100;
- Dash8-300;
- Beechcraft 1900D;
- Canadair RJ50;
- Dornier 328 Jet;
- Metro III;

- EMB 110;
- EMB 135; and
- De Havilland Twin Otter.

According to technical information available on the internet, it can also be assumed that the following aircraft can accommodate the four different wheelchair types considered:

- ATR 42;
- HS 748;
- Jetstream 31;
- Fokker 28;
- Saab 340;
- DC3;
- B 727; and
- Shorts 360.

It should be noted, however, that these conclusions have not been confirmed with manufacturers or air carriers.

4.1.3 Use of Small Aircraft by Region

Transport Canada's database of airports divides Canada's airports into the following regions: Pacific, Prairie and Northern, Ontario, Quebec, and Atlantic. We used this classification to analyze the distribution of departures of small aircraft across Canada.

Figure 4-1 shows the distribution of all departures, and Figures 4-2 through 4-6 show the distribution for selected most frequently used aircraft types. All figures refer to total departure volume during the sample period from April 1 to 15, 2000.

Figure 4-1: Total Departure Volume of Small Aircraft by Region

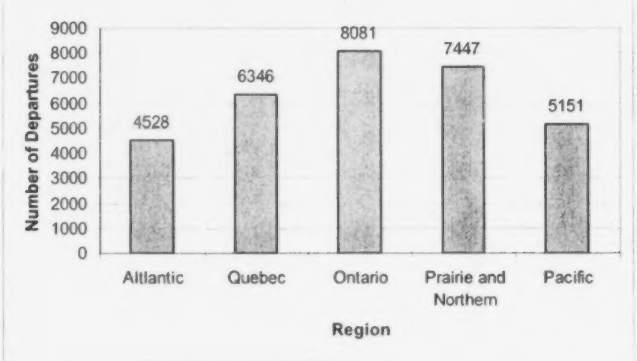


Figure 4-2: Departures of De Havilland Dash 8 – 100 by Region

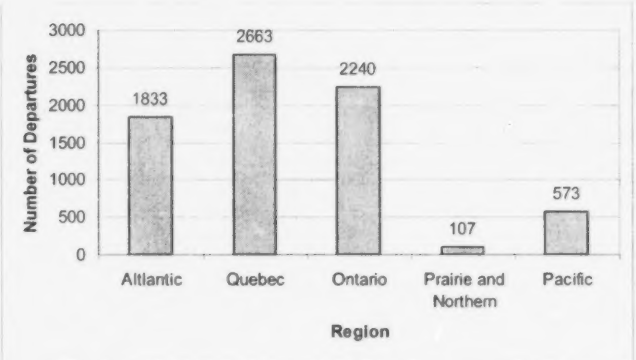


Figure 4-3: Departures of De Havilland Dash 8 – 300 by Region

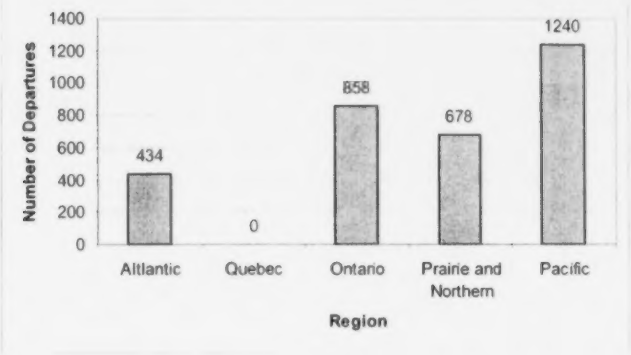


Figure 4-4: Departures of Beechcraft 1900 D by Region

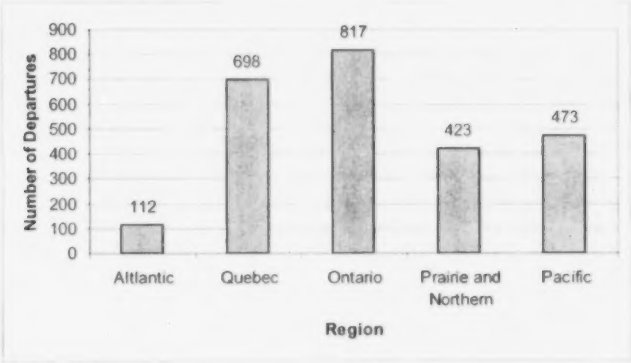


Figure 4-5: Departures of Canadair Regional Jet by Region

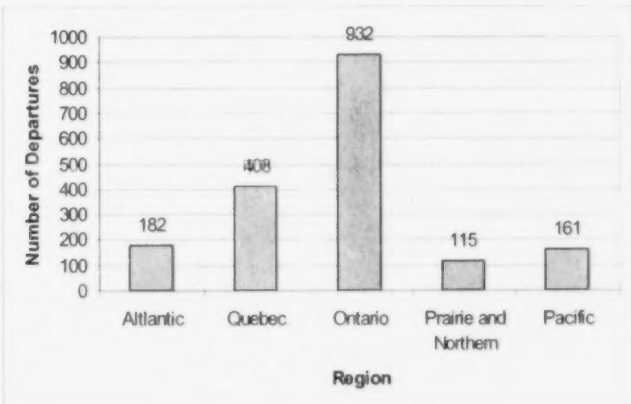


Figure 4-6: Departures of Fokker F-28 Fellowship All Series by Region

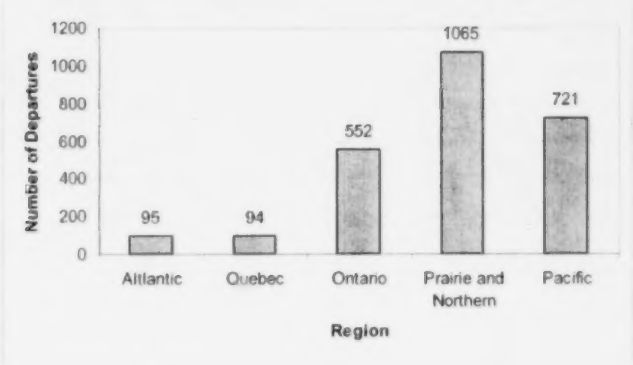


Figure 4-1 suggests that, overall, the use of small aircraft is more or less proportional to the population living in the areas analyzed. On the other hand, Figures 4-2 through 4-6 illustrate the existence of certain regional patterns in aircraft use; i.e. certain aircraft types are used more intensively in some regions of the country than in others.

4.1.4 Departures of Small Aircraft by Airport Size (as Measured by Departure Volume)

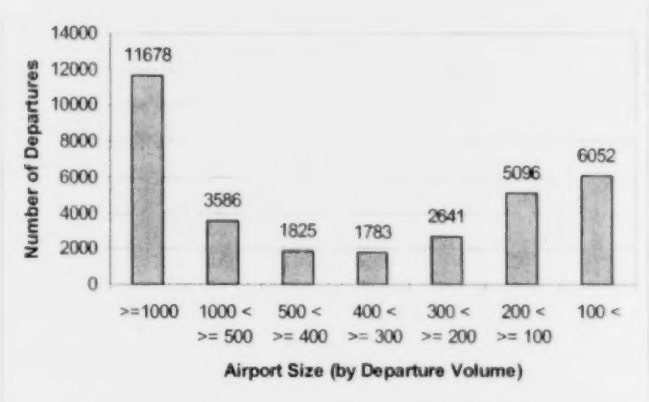
Figure 4.7 presents the aircraft departures broken down by airport size as measured by volume of departures. For this purpose, airports were classified into one of the following groups based on the number of total departures of small aircraft during the sample period (i.e. April 1 to 15, 2000):

- 1000 departures or more;
- 500 departures or more, but fewer than 1000;
- 400 departures or more, but fewer than 500;
- 300 departures or more, but fewer than 400;
- 200 departures or more, but fewer than 300;
- 100 departures or more, but fewer than 200; and
- fewer than 100 departures.

There were six airports in the first group of the largest airports, five airports in the second group, four airports in third group, five airports in the fourth group,

11 airports in the fifth group, 30 airports in the sixth group, and 128 airports in the smallest seventh group.

Figure 4-7: Departures of Small Aircraft by Airport Size Group



As Figure 4-7 indicates, the vast majority of departures were from the largest airports and from the smallest airports. The largest airport group accounted for approximately 33 percent of all departures, and the two smallest airport groups combined accounted for approximately 32 percent of all departures.

Below we analyze the five "most prolific" aircraft types (see Table 4-1 for the list of these aircraft). Figure 4-8 shows the percentage of departures accounted for by the "Top 5" aircraft combined, and Figures 4-9 through 4-12 show the number of departures for a given aircraft broken down by airport size (as defined previously).

Figure 4-8: Top 5 Aircraft Departures by Airport Size

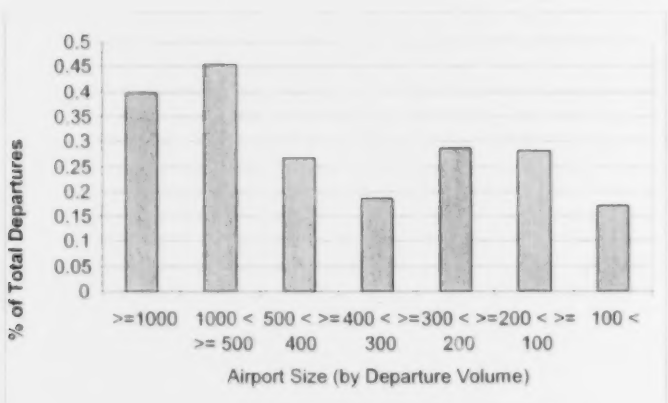


Figure 4-9: Departures of De Havilland Dash 8 – 100 by Airport Size Group

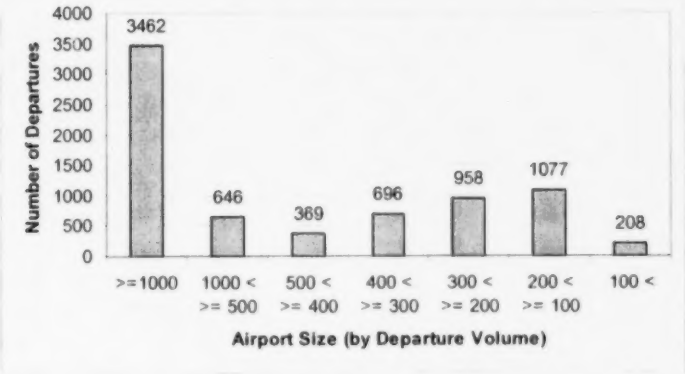


Figure 4-10: Departures of Beechcraft 1900D by Airport Size Group

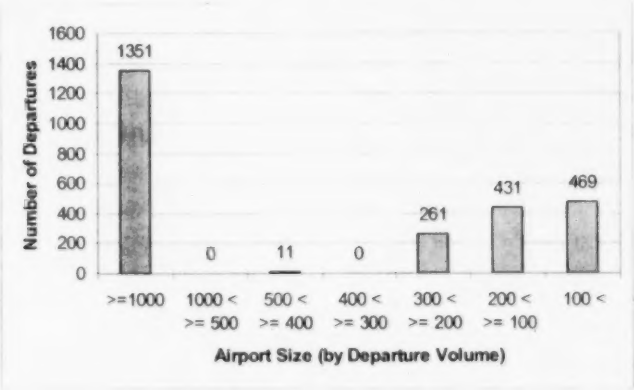


Figure 4-11: Departures of Canadair Regional Jet by Airport Size Group

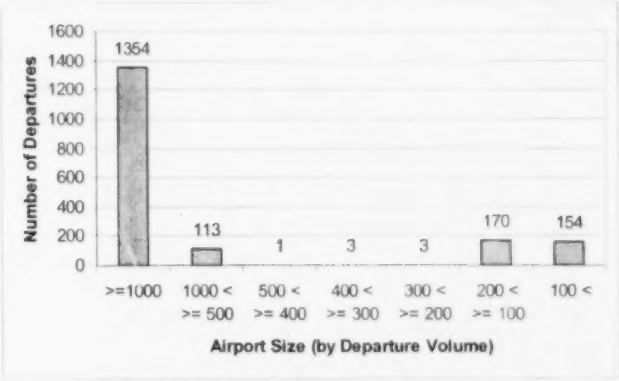


Figure 4-12: Departures of Fokker Fellowship F-28 All Series by Airport Size Group

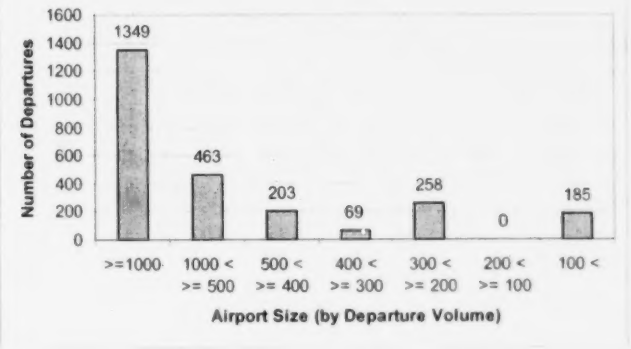


Figure 4-8 and Figures 4-9 through 4-12 indicate that there is a downward trend in the proportion of total departures accounted for by the most frequently used aircraft shown in Table 4-1 as we look at smaller and smaller airports. In other words, these aircraft are used primarily in large airports with at least 500 departures. This suggests that smaller airports, as a group, deal with a wider range of aircraft types than larger airports.

4.1.5 Summary of Small Aircraft Types Analysis

Table 4-1 shows that there are 23 different aircraft types serving Canadian airports. The top five aircraft types account for almost 60 percent of departures and the top seven aircraft types account for almost 75 percent of all departures. There is thus a large number of less "popular" or less frequently used aircraft types. These aircraft are used primarily in the smallest airports. On the other hand, the most frequently used aircraft go primarily to large airports, those that had at least 500 departures during the sample period from April 1 to 15, 2000.

The analysis also shows that the use of aircraft across the country is far from being uniform; there are some regional patterns in the sense that certain aircraft types are used in some regions more frequently than in others.

The largest airport group (six airports) accounted for 33 percent of all departures of small aircraft. On the other hand, the two smallest airport groups (158 airports) accounted for another 32 percent of all departures.

This pattern arises because large airports serve as hubs offering numerous connecting flights to smaller communities, which would be uneconomical to serve on large aircraft. However, some destinations are served on small aircraft but several times a day (as opposed to less frequent flights on larger equipment). On the other hand, smaller airports, located in small communities, would make the use of larger aircraft uneconomical.

Such a pattern of small aircraft use also implies that availability of equipment for boarding small aircraft and its use in small communities may have a significant impact on the general boarding situation. In particular, if smaller airports are less likely to have a boarding device and if some smaller communities have a larger incidence of disabilities, a relatively large proportion of persons with a disability may have poor access to air transportation.

4.2 Airports Serving Small Aircraft

The OAG database identifies 189 Canadian airports that serve small aircraft with 19 to 60 passenger seats.

Sections 4.2.1 through 4.2.7 provide a detailed list of these airports by the number of departures according to the breakdown used in Section 4.1.4. We also identify the five most frequently used aircraft within each airport group.

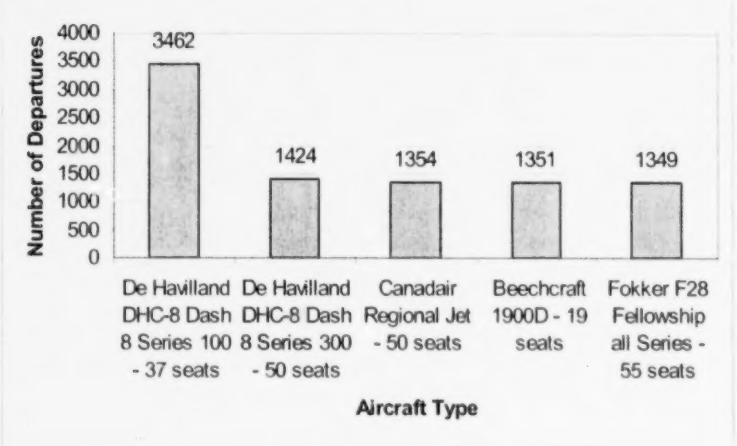
4.2.1 Airports with at Least 1000 Departures

Six airports with more than 1000 departures during the sample period were identified. Table 4-2 lists them, and Figure 13 shows the most frequently used aircraft.

Table 4-2: List of Airports with More Than 1000 Departures

AIRPORT NAME	PROVINCE	DEPARTURE VOLUME
Toronto Lester B. Pearson International Airport	Ontario	3163
Vancouver International Airport	British Columbia	2489
Montreal Dorval International Airport	Quebec	2446
Ottawa Mcdonald-Cartier International Airport	Ontario	1373
Calgary International Airport	Alberta	1131
Quebec City Jean-Lesage International Airport	Quebec	1076

Figure 4-13: Top 5 Aircraft: Airports with at Least 1000 Departures



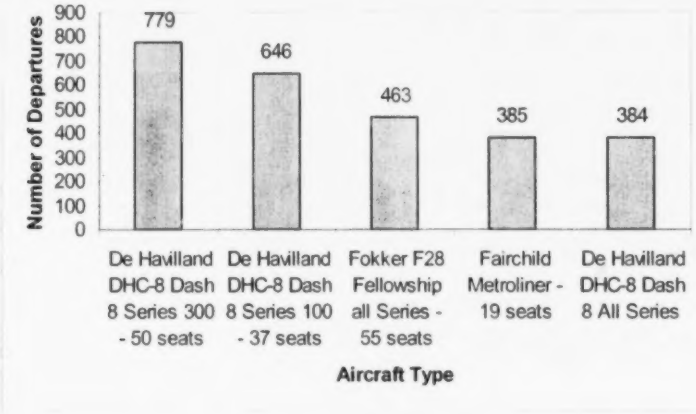
4.2.2 Airports with 500 to 999 Departures

There were five airports in the OAG database with the departure volume during the sample period in the range between 500 and 999. Table 4-3 lists these airports and Figure 4-14 shows the most frequently used small aircraft.

Table 4-3: List of Airports with 500 – 999 Departures

AIRPORT NAME	PROVINCE	DEPARTURE VOLUME
Winnipeg International Airport	Manitoba	978
Halifax International Airport	Nova Scotia	924
Edmonton International Airport	Alberta	650
Saskatoon John G. Diefenbaker International Airport	Saskatchewan	521
Victoria International Airport	British Columbia	513

Figure 4-14: Top 5 Aircraft: Airports with 500 – 999 Departures



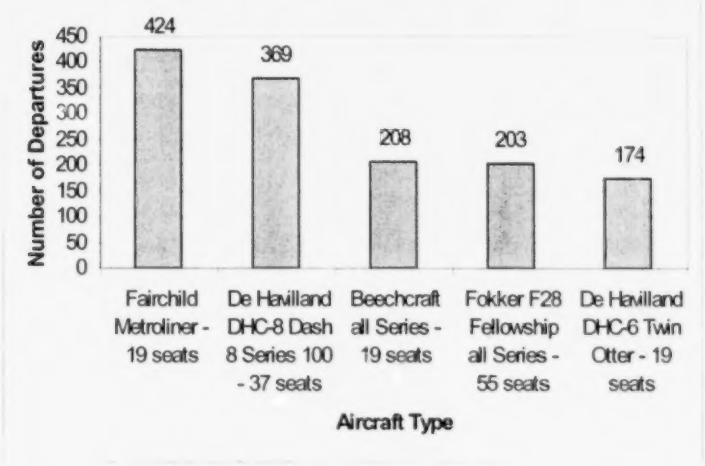
4.2.3 Airports with 400 to 499 Departures

There were four airports in the OAG database with the departure volume during the sample period in the range between 400 and 499. Table 4-4 lists these airports and Figure 4-15 shows the most frequently used small aircraft.

Table 4-4: List of Airports with 400 - 499 Departures

AIRPORT NAME	PROVINCE	DEPARTURE VOLUME
Thunder Bay International Airport	Ontario	487
Regina Airport	Saskatchewan	453
Goose Bay Airport	Newfoundland	452
London Municipal Airport	Ontario	433

Figure 4-15: Top 5 Aircraft: Airports with 400 - 499 Departures



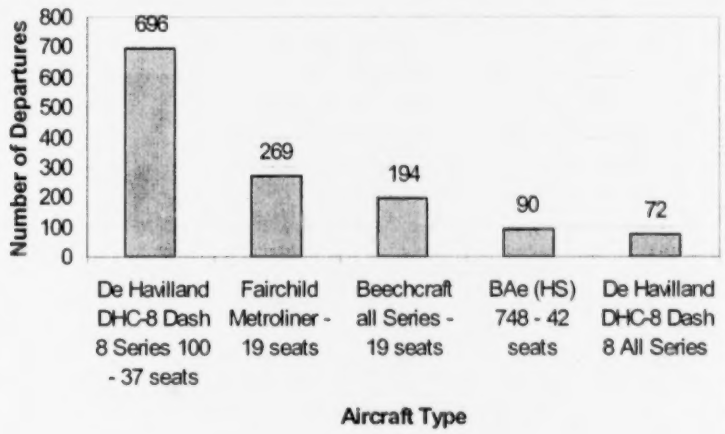
4.2.4 Airports with 300 to 399 Departures

There were five airports in the OAG database with the departure volume during the sample period in the range between 300 and 399. Table 4-5 lists these airports and Figure 4-16 shows the most frequently used small aircraft.

Table 4-5: List of Airports with 300 to 399 Departures

AIRPORT NAME	PROVINCE	DEPARTURE VOLUME
St. John's International Airport	Newfoundland	391
Sept-Iles Airport	Quebec	316
Thompson Municipal Airport	Manitoba	201
Greater Sudbury Airport	Ontario	325
Saint John Airport	New Brunswick	317

Figure 4-16: Top 5 Aircraft: Airports with 300 – 399 Departures



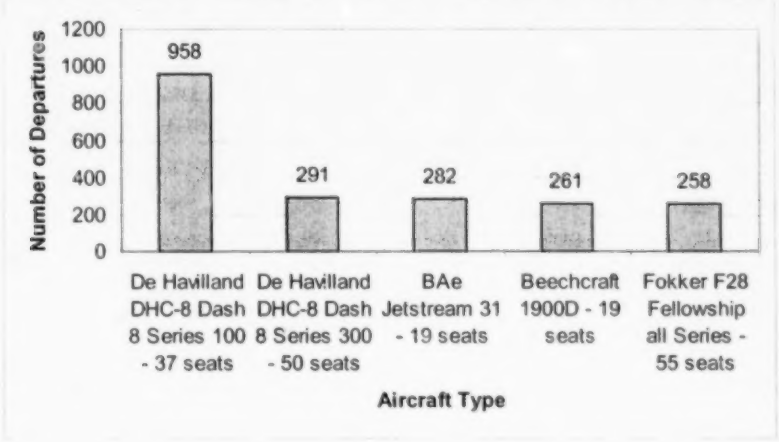
4.2.5 Airports with 200 to 299 Departures

There were 11 airports in the OAG database with the departure volume during the sample period in the range between 200 and 299. Table 4-6 lists these airports and Figure 4-17 shows the most frequently used small aircraft.

Table 4-6: List of Airports with 200 – 299 Departures

AIRPORT NAME	PROVINCE	DEPARTURE VOLUME
Kelowna International Airport	British Columbia	299
Greater Fredericton Airport	New Brunswick	274
Windsor Airport	Ontario	271
Prince Albert Airport	Saskatchewan	248
Timmins Airport	Ontario	233
Toronto City Centre Airport	Ontario	230
La Ronge Airport	Saskatchewan	224
Mont Joli Airport	Quebec	220
Sault Ste. Marie Airport	Ontario	219
Prince George Airport	British Columbia	218
Val d'Or Regional Airport	Quebec	205

Figure 4-17: Top 5 Aircraft: Airports with 200 - 299 Departures



4.2.6 Airports with 100 to 199 Departures

There were 30 airports in the OAG database with the departure volume during the sample period in the range between 100 and 199. Table 4-7 lists these airports and Figure 4-18 shows the most frequently used small aircraft.

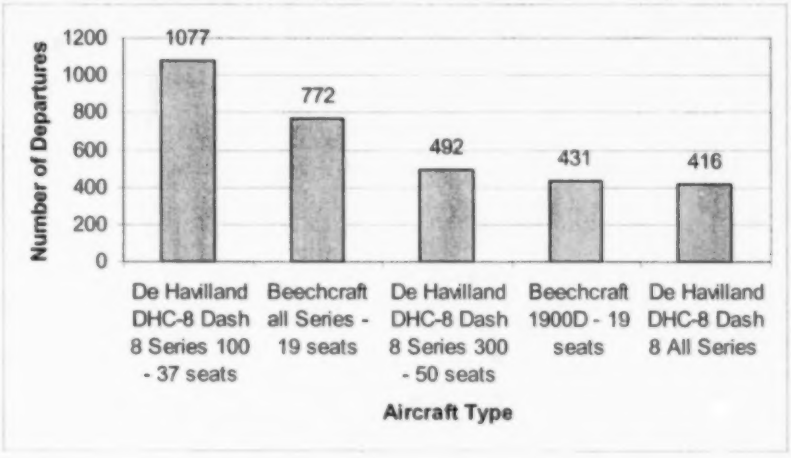
Table 4-7: List of Airports with 100 - 199 Departures

AIRPORT NAME	PROVINCE	DEPARTURE VOLUME
Nanaimo Cassidy Airport	British Columbia	189
Lourdes-de-Blanc-Sablon Airport	Quebec	148
Chevery Airport	Quebec	148
Natashquan Airport	Quebec	126
Campbell River Municipal Airport	British Columbia	177
Sydney Airport	Nova Scotia	177
St. Anthony Airport	Newfoundland	175
Deer Lake Airport	Newfoundland	173
Grande Prairie Airport	Alberta	169
Wabush Airport	Newfoundland	161
Charlottetown Airport	Prince Edward Island	167
Stony Rapids Airport	Saskatchewan	166
Kingston Norman Rogers Airport	Ontario	163
Iles-de-la-Madeleine Airport	Quebec	161

Table 4-7 (continued)

AIRPORT NAME	PROVINCE	DEPARTURE VOLUME
Baie Comeau Airport	Quebec	159
Kamloops Airport	British Columbia	158
Comox Airport	British Columbia	151
Fond-du-Lac Airport	Saskatchewan	148
Gander International Airport	Newfoundland	145
Rankin Inlet Airport	Nunavut	107
Churchill Airport	Manitoba	105
Rouyn-Noranda Airport	Quebec	141
Bagotville Airport	Quebec	138
North Bay Jack Garland Airport	Ontario	136
Stephenville Airport	Newfoundland	130
Gaspé Airport	Quebec	128
Moncton International Airport	New Brunswick	122
Sarnia Chris Hadfield Airport	Ontario	108
Fort McMurray Airport	Alberta	104
Waskaganish Airport	Quebec	100

Figure 4-18: Top 5 Aircraft: Airports with 100 – 199 Departures



4.2.7 Airports with Fewer Than 100 Departures

There were 128 airports in the OAG database with the departure volume during the sample period of less than 100. Table 4-8 lists these airports and Figure 4-19 shows the most frequently used small aircraft.

Table 4-8: List of Airports with Fewer Than 100 Departures

AIRPORT	PROVINCE	DEPARTURE VOLUME	AIRPORT	PROVINCE	DEPARTURE VOLUME
Cranbrook	BC	98	Gethsemani	QC	43
Dryden	ON	97	Terrace	BC	42
Attawapiskat	ON	96	Points North Landing	SK	40
Fort Albany	ON	96	Fort Hope	ON	39
Kaschechewan	ON	96	Inukjuak	QC	38
Moosonee	ON	96	Puvirnituq	QC	38
Hamilton	ON	92	Red Sucker Lake	MB	38
Dawson Creek	BC	90	Williams Lake	BC	38
Nain	NF	90	Banff	AB	37
Penticton	BC	90	Dawson City	YT	36
Fort St. John	BC	87	The Pas	MB	36
Baker Lake	NU	84	Whitehorse	YT	36
Lethbridge	AB	84	Wollaston Lake	SK	36
Castlegar	BC	83	Old Crow	YT	34
Norman Wells	NT	82	Shamattawa	MB	20
Sioux Lookout	ON	79	Gillam	MB	32
Havre St. Pierre	QC	78	High Level	AB	32
Kuujjuarapik	QC	78	Iqaluit	NU	31
Gods Narrows	MB	41	Tadoule Lake	MB	25
Yellowknife	NT	75	Anahim Lake	BC	30
Gods River	MB	34	Bella Bella	BC	30
Rigolet	NF	72	Bella Coola	BC	30
Whale Cove	NU	34	Dauphin	MB	30
Black Tickle	NF	70	Kegaska	QC	30

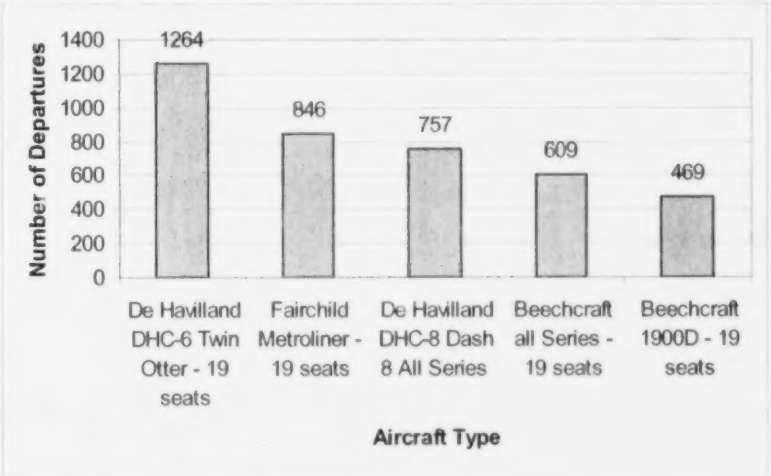
Table 4-8: List of Airports with Fewer Than 100 Departures (continued)

AIRPORT	PROVINCE	DEPARTURE VOLUME	AIRPORT	PROVINCE	DEPARTURE VOLUME
Cartwright	NF	70	Ottawa Gatineau	QC	30
Charlottetown	NF	70	Port Hardy	BC	30
Cross Lake	MB	70	Lynn Lake	MB	28
Fox Harbour	NF	70	Tuktoyaktuk	NT	28
Makkovik	NF	70	Cambridge Bay	NU	27
Mary's Harbour	NF	70	Prince Rupert Digby Isl	BC	27
Norway House	MB	70	Sandspit	BC	27
Port Hope Simpson	NF	70	Hay River	NT	26
Ste. Therese Point	MB	58	Rainbow Lake	AB	24
Flin Flon	MB	69	Resolute	NU	24
Postville	NF	68	St. Leonard	NB	15
Hopedale	NF	66	Berens River	MB	22
Quesnel	BC	62	Kitchener	ON	22
Tulita Fort Norman	NT	62	Lloydminster	AB	22
Island Lake/Garden Hill	MB	55	Fort Good Hope	NT	21
Brandon	MB	60	Gjoa Haven	NU	21
Chisasibi	QC	60	Pelly Bay Townsite	NU	21
East Main	QC	60	Taloyoak	NU	21
Inuvik	NT	60	Repulse Bay	NU	20
Wemindji	QC	60	Tete-a-la Baleine	QC	20
Fort Smith	NT	59	South Indian Lake	MB	18
Smithers	BC	58	Umiujaq	QC	12
Bonaventure	QC	57	Churchill Falls	NF	16

Table 4-8: List of Airports with Fewer Than 100 Departures (continued)

AIRPORT	PROVINCE	DEPARTURE VOLUME	AIRPORT	PROVINCE	DEPARTURE VOLUME
Deline	NT	56	Schefferville	QC	16
Peawanuck	ON	56	Chesterfield Inlet	NU	14
Bathurst	NB	55	Fort Frances	ON	14
Brochet	MB	55	Ogoki	ON	13
Medicine Hat	AB	55	Leaf Rapids	MB	12
Port Alberni	BC	55	Nanisivik	NU	12
Qualicum	BC	35	Pukatawagan	MB	10
Nakina	ON	52	Coral Harbour	NU	10
Chibougamau	QC	50	Paulatuk	NT	10
La Grande	QC	50	Roberval	QC	10
Lac Brochet	MB	49	Holman Island	NT	8
Davis Inlet	NF	48	Sanikiluaq	NU	8
Kenora	ON	48	Colville Lake	NT	7
Oxford House	MB	17	Kugluktuk Coppermine	NU	6
Peace River	AB	46	Kuujjuaq	QC	6
Fort Nelson	BC	45	Pond Inlet	NU	4
Red Lake	ON	44	Arctic Bay	NU	2

Figure 4-19: Top 5 Aircraft: Airports with Fewer Than 100 Departures



4.2.8 Summary of Airport Analysis

As expected, large airports are served primarily by larger aircraft of the five top aircraft, 50-seaters and 37-seaters. Smaller aircraft, 19-seaters, are used most intensively in the group of smallest airports (with fewer than 100 departures). However, these aircraft are also frequently used in medium-sized airports (with 400 to 500 departures).

The analysis also suggests that there are one to two "dominant" aircraft serving the given airport group, which accounts for about 30 to 40 percent of all departures. The remaining departures are accounted for by a relatively large number of other aircraft types.

Table 4-9 shows the number of aircraft types serving airports of different sizes (to simplify the table, airport sizes were aggregated into three groups). The first row shows the number (exactly speaking, the range of numbers) of aircraft types serving any selected airport from the group of the given size. For example, an airport from the largest group is served by at least three aircraft types but the number of aircraft types may be as large as 13. The second row in this table shows the total number of aircraft types that can be observed in the entire group size. For example, the largest airports – as a group – are served by 20 different aircraft types.

Table 4-9: Number of Aircraft Types for Each Airport Size Group

	Airport Size (No. of Departures from April 1 to 15, 2000)		
	500+ (11 airports)	**200-499 (20 airports)**	**Fewer Than 200 (158 airports)**
Range of Aircraft Types at an Airport in Size Group	3 - 13	1 - 6	1 - 5
Total Number of Aircraft Types in Size Group	20	15	19

As expected, individual large airports deal with a larger number of aircraft than smaller airports. However, collectively, small airports are served by almost as large a number of aircraft types as the largest airports. This suggests that the distribution of aircraft types across the country and regions is highly non-uniform.

4.3 Air Carriers Using Small Aircraft

4.3.1 Carriers on the Market where Small Aircraft Operate

The Canadian carriers and their flight volume during the period from April 1 to 15, 2000, are listed in Table 4-10.

Table 4-10: Canadian Air Carriers in the OAG Database

CANADIAN CARRIER	FLIGHT VOLUME	PERCENTAGE OF ALL FLIGHTS
Air Canada	15294	52.0%
Canadian Airlines International	6374	21.7%
Bearskin Airlines	1229	4.2%
Air Creebec (1994) Inc.	1152	3.9%
Labrador Airways	1036	3.5%
Regionnair Inc.	959	3.3%
Air Sask Aviation 1991	810	2.8%
Pacific Coastal Airlines Limited	700	2.4%
Provincial Airlines	346	1.2%
First Air	291	1.0%
North-Wright Airways Ltd.	262	0.9%
Northwest Airlines	244	0.8%
Aklak Air	188	0.6%
Aviation Quebec Labrador	186	0.6%
Air North	132	0.4%
K.D. Air Corporation	110	0.4%
Pem-Air	44	0.1%
Air Montreal	40	0.1%
Air Alliance	4	0.0%

As the table shows, Air Canada accounted for over 50 percent of all flights flown by Canadian carriers, and Canadian Airlines (still in operation during that period) accounted for another 22 percent.[12] Seventeen airlines accounted for the remaining 23 percent. Their share of flight volume was in the

[12] If US carriers were taken into account, these shares would fall but the combined share of Air Canada and Canadian Airlines would still amount to 64 percent.

range between 4.2 and less than 0.1 percent. Nine airlines accounted for less than 1 percent of flight volume each.

4.3.2 Patterns of Small Aircraft Use by Canadian Air Carriers

In Tables 4-11 through to 4-15, we specify the complete fleet of the five largest Canadian carriers in our database.

Table 4-11: Aircraft Used by Air Canada

AIRCRAFT FLOWN BY AIR CANADA	FLIGHT VOLUME
De Havilland DHC-8 Dash 8 Series 100 - 37 seats	8109
Beechcraft 1900D - 19 seats	2770
De Havilland DHC-8 Dash 8 Series 300 - 50 seats	2205
Canadair Regional Jet - 50 seats	1960
De Havilland DHC-8 Dash 8 All Series - 37 seats	233
BAe Jetstream 31 - 19 seats	17

Table 4-12: Aircraft Used by Canadian Airlines

AIRCRAFT FLOWN BY CANADIAN AIRLINES	FLIGHT VOLUME
Fokker F28 Fellowship All Series	2680
De Havilland DHC-8 Dash 8 Series 300 - 50 seats	1218
De Havilland DHC-8 Dash 8 All Series - 37 seats	990
Saab SF 340 - 34 seats	739
BAe (HS) 748 - 42 seats	486
De Havilland DHC-6 Twin Otter - 37 seats	108
Bus	72
ATR All Series	36
Shorts 360 - 30 seats	32
Fairchild Metroliner - 19 seats	10
Beechcraft All Series - 19 seats	3

Table 4-13: Aircraft Used by Bearskin Airlines

AIRCRAFT FLOWN BY BEARSKIN AIRLINES	FLIGHT VOLUME
Fairchild Metroliner - 19 seats	1229

Table 4-14: Aircraft Used by Air Creebec

AIRCRAFT FLOWN BY AIR CREEBEC INC.	FLIGHT VOLUME
Beechcraft All Series - 19 seats	632
De Havilland DHC-8 Dash 8 All Series - 37 seats	520

Table 4-15: Aircraft Used by Labrador Airways

AIRCRAFT FLOWN BY LABRADOR AIRWAYS	FLIGHT VOLUME
De Havilland DHC-6 Twin Otter - 19 seats	1036

Comparing Table 4-10 with Tables 4-11 through 4-15, we can see that airlines are highly focused in their use of aircraft. Large airlines, Air Canada and Canadian Airlines serve 98 percent and 88 percent of their flights, respectively, on four aircraft types. Small airlines have one to two aircraft types. These aircraft types do not overlap across airlines; aircraft used intensively by one airline are not necessarily used with the same intensity by another airline. For example, Bearskin Airlines serves its entire traffic on the Fairchild Metroliner, and Labrador Airways serves its entire traffic on the 19-seater Twin Otter.

Table 4-16 lists Canadian air carriers ranked by the total number of destination airports served.

Table 4-16: Number of Airports Served by Canadian Air Carriers

CARRIER NAME	NUMBER OF DEPARTURE AIRPORTS
Air Canada	98
Canadian Airlines	71
Air Creebec	17
Labrador Airways	17
Skyward Aviation	16
Bearskin Airlines	14
First Air	13
Perimeter Airlines	13
Regionnair Inc.	11
Aklak Air	10
Air Sask Aviation	8
Athabaska Airways	8
Pacific Coastal Airlines	8
Provincial Airlines	8
Air Montreal	7
North-Wright Airways	7
Air North	5
Aviation Quebec Labrador	5
Kenn Borek Air	5
Nakina Air Service	5
Northwest Airlines	5
Northwestern Air Lease	4
Air Alliance	2
Buffalo Airways	2
K.D. Air Transportation	2
Pem-Air	2
SABENA	2
West Coast Air	2

As Table 4-16 indicates, larger carriers in terms of flight volume also tend to serve more airports. Air Canada and Canadian Airlines have the most

comprehensive coverage in terms of the number of airports served. Collectively, these two airlines (and now just one airline) serve over 100 airports. The remaining airlines are regional in nature serving fewer than 20 airports.

Comparing Tables 4-10 and 4-16, we can also see that larger airlines tend to use their airports on average more "intensively" in the sense of having more departures on small aircraft per airport served.

4.3.3 Summary of Air Carrier Analysis

At the time of data collection, there were 19 air carriers (and 18 after the merger of Canadian Airlines with Air Canada) in the Canadian airline industry that use small aircraft with 19 to 60 passenger seats to serve scheduled flights. Air Canada accounts for the vast majority of the flight volume. The largest of the remaining airlines accounts for just 4.2 percent of the flight volume and a number of airlines account for less than 1 percent of the flight volume. However, even the smaller airlines had several flights a day during the period considered and thus they may have an impact on the perception as to the situation with respect to boarding of small aircraft.

Airlines tend to use just a few aircraft types (and one to two aircraft types in the case of smaller airlines), and various airlines use various aircraft. (For example, Bearskin Airlines use different aircraft types than Air Creebec.)

As expected and indicated in Table 4-16, larger carriers in terms of flight volume also tended to serve more airports. But, comparing Table 4-16 with Table 4-11, we can also see that larger airlines tend to use their airports on average more "intensively" in the sense of having more departures on small aircraft per airport served.

4.4 Implications of the Pattern of Small Aircraft Use

Although over 40 percent of departures on small aircraft take place on the Dash 8, there are 20 other small aircraft types used in Canada. These aircraft can carry a mobility aid but can be accessed using only a narrow boarding chair. The use of these aircraft varies by region and air carrier; some aircraft are used more intensively in certain regions of the country than others, and some small aircraft are used intensively by certain carriers but less so by others. The analysis also showed that smaller airports, collectively, tend to deal with a larger number of

aircraft types than medium-sized airports, and almost as large a number of aircraft types as the largest group of airports.

The majority of flights are served by Air Canada/Canadian Airlines. But there also are 17 other air carriers in the market. These small air carriers serve relatively more airports (compared to the departure volume) than the largest Canadian air carrier.

The characteristics of the market where small aircraft operate may have some implications for a detailed analysis of boarding, required improvements, and the development of policy guidelines or standards. Following are some potential problems:

- To the extent that effective boarding devices are compatible only with a relatively narrow range of small aircraft, or that they are more difficult to set up and use with certain aircraft than with others, it may be difficult to implement general cost-effective standards.
- Smaller airports that serve more than one aircraft type may carry a relatively large financial burden of purchasing devices compatible with all aircraft using that airport and training staff in boarding procedures. They may require financial/technical assistance.
- Similarly, smaller air carriers face a relatively larger financial burden of purchasing an effective boarding device for all its destination airports.
- If it is easier to board a passenger with a disability on certain aircraft than on others, perceptions as to existing problems and improvements required will differ across regions of the country.

4.5 Aircraft Types Selected for Further Detailed Study and Boarding Demonstrations

As explained in Section 2, the second part of the project involved inspections of selected aircraft types and live boarding demonstrations to determine aisle and seating accessibility for small aircraft most commonly used in scheduled air service in Canada. As this phase of the study was taking place in 2002, an update of small aircraft use in Canada was deemed necessary.

For this purpose, HLB requested a sample database of flight schedules (from OAG) involving small aircraft for all scheduled air services in Canada for the

period from February 4 to 10, 2002. This sample contained 2222 flight records, each with information similar to that for the first sample, i.e. departure time, arrival time, departure airport, arrival airport, aircraft type, seat capacity, flight number, etc.

The analysis of the 2002 OAG data sample revealed that the fleet of small aircraft in Canada had not changed substantially since early 2000. For reference and comparison, Table 4-17 shows small aircraft used in Canada in early 2002.

Table 4-17: Small Aircraft Used in Canada, 2002 Update

RANK*	AIRCRAFT NAME	SEATS	PERCENTAGE OF FLIGHTS	CUMULATIVE PERCENTAGE OF FLIGHTS
1	De Havilland DHC-8 Dash 8-100	37	30.87	30.87
2	Beechcraft 1900D	19	11.52	42.39
3	De Havilland DHC-8 Dash 8 Series 300	50	11.34	53.74
4	Canadair Regional Jet	50	10.35	64.09
5**	De Havilland DHC8 Dash-8 (100 and 300)	37-50	7.07	71.15
6	Saab SF 340	34	4.95	76.10
7	De Havilland DHC-6 Twin Otter	19	4.86	80.96
8	Fairchild Metroliner	19	4.59	85.55
9	Shorts 360	33	2.57	88.12
10	Embraer RJ 135 /140 /145	37-50	2.52	90.64
11	BAe (HS) 748	37-46	1.62	92.26
12	Embraer RJ135	37	1.49	93.74
13	Beechcraft All Series	19	1.40	95.14
14	BAe Jetstream 31	19	1.26	96.40
15	Fairchild Dornier 328	29	0.81	97.21

Table 4-17: Small Aircraft Used in Canada, 2002 Update (continued)

RANK*	AIRCRAFT NAME	SEATS	PERCENTAGE OF FLIGHTS	CUMULATIVE PERCENTAGE OF FLIGHTS
16	ATR All Series	37-50	0.63	97.84
17	Fairchild Dornier 328jet	32	0.63	98.47
18	Boeing 727 (Mixed Configuration)	19	0.59	99.05
19	Embraer EMB-120 Brasilia	30	0.54	99.59
20	Douglas DC3 /C-47 Dakota (Passenger)	27	0.18	99.77
21	Embraer RJ140	50	0.18	99.95
22	ATR 42	37	0.05	100.00

NOTES TO TABLE 4-17:

*A ranking could also have been made on the basis of passenger trips; however, these data were not available.

** De Havilland DHC-8 Dash 8 (100 and 300) includes both Dash 8-100 and Dash 8-300. This entry refers to those flights for which OAG did not have precise information on the aircraft type (i.e. Dash 8-100 or Dash 8-300).

Table 4-17 shows that the most frequently used aircraft is still the Dash 8-100. It accounts for over 20 percent of all flights. Other frequently used aircraft types are the Beechcraft 1900D, Dash 8-300, and Canadair Regional Jet. Each of these aircraft types accounts for approximately 10 percent of all flights. The remaining aircraft types are used much less frequently, with no aircraft type accounting for more than 5 percent of flights. Therefore, the four most frequently used aircraft types account for over 70 percent of flight volume.

The 2002 OAG data sample also provided information on air carriers offering scheduled services on small aircraft. Table 4.18 provides a list of these carriers.

Table 4-18: Air Carriers Using Small Aircraft in Canada, 2002 Update

RANK	AIR CARRIER	PERCENTAGE OF FLIGHTS	CUMULATIVE PERCENTAGE OF FLIGHTS
1	Air Canada	62.29	62.29
2	Bearskin Airlines	4.28	66.56
3	Delta Air Lines	3.29	69.85
4	Pacific Coastal Airlines Limited	3.11	72.95
5	Labrador Airways	2.97	75.92
6	Continental Airlines	2.93	78.85
7	First Air	2.79	81.64
8	Provincial Airlines	2.66	84.29
9	Air Creebec (1994) Inc.	2.48	86.77
10	Alaska Airlines	2.43	89.20
11	US Airways	1.94	91.13
12	Aklak Air	1.35	92.48
13	American Airlines	1.17	93.65
14	Harbour Air Ltd	1.08	94.73
15	Northwest Airlines	0.81	95.54
16	Hawkair	0.72	96.26
17	Northwestern Air Lease Ltd.	0.63	96.89
18	United Airlines	0.54	97.43
19	Air North	0.45	97.88
20	Calm Air Intl Ltd	0.45	98.33
21	Transwest Air	0.41	98.74
22	Skyward Aviation Ltd	0.36	99.10
23	America West Airlines	0.27	99.37

Table 4-18: Air Carriers Using Small Aircraft in Canada, 2002 Update (continued)

RANK	AIR CARRIER	PERCENTAGE OF FLIGHTS	CUMULATIVE PERCENTAGE OF FLIGHTS
24	Pem-Air	0.23	99.59
25	Buffalo Airways Ltd.	0.18	99.77
26	Midwest Express Airlines Inc.	0.18	99.95
27	Air Saint-Pierre	0.05	100.00

Table 4-18 shows that there were 27 airlines providing scheduled services on small aircraft in Canada in 2002. The list of these airlines is somewhat different than that in Table 4-11. This is due to the changes that took place in the airline industry in 2000 and 2001, primarily the merger of Canadian Airlines with Air Canada. As a result of this merger, Air Canada became the largest Canadian carrier, accounting for over 62 percent of all flights. Bearskin Airlines was the second largest carrier, accounting for about 4 percent of flight volume.

A few airlines shown in Table 4-18 are American-based air carriers. These carriers serve cross-border routes between Canada and the US.

Table 4-19 shows the composition of small aircraft fleet for the five largest Canadian air carriers.

Table 4-19: Fleet Composition of the Five Largest Canadian Air Carriers Using Small Aircraft in Canada

AIRCRAFT	Air Canada	Bearskin Airlines	Pacific Coastal Airlines	Labrador Airways	First Air
BAe (HS) 748	X				X
Beechcraft 1900D	X		X	X	X
Canadair Regional Jet	X				
De Havilland DHC-8 Dash 8 100	X				X
De Havilland DHC-8 Dash 8 300	X				X
De Havilland DHC-6 Twin Otter				X	
Saab SF 340	X				
Fairchild Metroliner		X			
Shorts 360			X		
Boeing 727					X

Table 4-19 shows that the largest carriers typically use aircraft types that appear as the most frequently used aircraft types in Table 4-1. Thus, this table provides a good initial set of aircraft types worthy of further investigation. Due to operational constraints, this set had to be narrowed down to aircraft types that are accessible for inspection in the Ottawa, Dorval, or Toronto airports. Table 4-20 shows representative aircraft types. Note that the ATR 42 is also included in Table 4-20 as one carrier indicated that it is purchasing 12 aircraft of this model.

Table 4-20: Aircraft Types Selected for Inspections and Live Boarding Demonstrations and Their Location

AIRCRAFT TYPE	LOCATION
Dash 8-100	Ottawa, Dorval, Toronto
Dash 8-300	Ottawa, Dorval, Toronto
Beechcraft 1900D	Dorval
Metroliner	Ottawa, Toronto
Canadair Regional Jet	Ottawa, Dorval
HS 748	Ottawa, Dorval
ATR 42	Ottawa, Dorval

According to the 2002 OAG data sample, the selected aircraft types accounted for over 77 percent of flight volume on small aircraft. The results of the study should therefore give a representative picture of the accessibility of destinations served by small aircraft to passengers with mobility impairments.

4.6 Current Trends in the Use of Small Aircraft by Canadian Carriers

Interviews with air carriers revealed the following trends in the use of various aircraft types:

1. Air Canada is completely retiring its fleet of the Fokker 28 aircraft series in September 2002.
2. Air Canada is phasing out its fleet of six Beechcraft 1900 aircraft and giving them to Georgian Airlines in September 2002. Air Canada will no longer fly this aircraft on its routes. Georgian Airlines is under contract for Air Canada and will provide regional services, operating out of Pearson Airport. Georgian Airlines is currently flying a substantial fleet of Beechcraft 1900 aircraft.
3. In the future, Regional Jets, new Dash 8s or ATR 42s will replace the aging Dash 8 series.
4. First Air has ordered several new ATR 42s for its services.

5: SURVEY RESULTS AND ANALYSIS: CHARACTERISTICS OF BOARDING DEVICES

Boarding a passenger using a mobility aid onto a small aircraft involves several steps that can be divided into two broad categories of procedures:

1. "Level change", or raising the passenger to the aircraft door, and
2. Moving the passenger from the aircraft door to his/her seat on board the aircraft.

Boarding technologies available on the market for level change can be divided into five categories:

- Boarding chairs;
- Stair climbers;
- Mechanical lifts;
- Ramps; and
- Bridges (low-level loading bridges).

Moving passengers from the aircraft door into the aisle and to their seat in the aircraft requires the use of:

- Boarding chairs, or
- Transfer chairs.

Note that boarding chairs can be used for both level change and moving passengers to their seat.

The first part of this project concentrated on level change and thus examined in detail level change devices, in particular mechanical devices (but also boarding chairs). On the other hand, the second part concentrated on the procedure of moving the passenger from the aircraft door to the seat, and thus examined in more detail boarding and transfer chairs.

To facilitate the presentation of results achieved in the two phases and to preserve the breakdown of boarding by categories of procedure (i.e. level change and moving to seat in aircraft), this section discusses first stair

climbers, mechanical lifts, ramps and bridges, and then moves on to examine boarding chairs.

5.1 Level Change Devices: Stair Climbers, Lifts, Ramps, and Bridges

In the survey of airports and air carriers, only two categories of level change devices were used with small aircraft: boarding chairs and mechanical lifts.

Additional research indicated that one low-level boarding bridge is used at the Edmonton International Airport. The Ottawa Mcdonald-Cartier International Airport had such a bridge in the past on an experimental basis. The Kelowna International Airport installed a low-level boarding bridge in late 2000 (after the survey results were collected).

To our knowledge, ramps and stair climbers are not used in Canada as a means of providing access to small aircraft.

The following sub-sections present the results of the survey and analysis discussing operational characteristics, compatibility with small aircraft, and effectiveness.

5.1.1 Description and Operational Features

Table 5-1 provides a summary description of stair climbers, lifts, ramps and bridges available on the market at the time when surveys were administered (i.e. summer 2000). The last column in this table indicates whether the device is used in Canadian airports, according to the survey of airports and air carriers. A more detailed description follows after the table.

Table 5-1: Stair Climbers, Mechanical Lifts, Ramps, and Bridges: Description, Price Range and Use in Canadian Airports

DEVICE	DESCRIPTION	PRICE RANGE	USED IN THE SURVEY YES/NO (NO. OF AIRPORTS)
Stair Trac	Portable, battery powered stair climber, operated by one person.	Medium	NO
Turbo way ramp	Non-motorized ramp with overhead weather protection.	High	NO
Mobilift	Non-motorized unit, manual (cranking) lift operation, set up by one person.	High	YES (5)
Just Mobility lift	Motorized unit, powered lifting, one person operation.	High	YES (1)
Elevator platform	Motorized unit, powered lifting, one person operation, weather protection.	High	YES (3)
Lift-a-loft	Self-propelled unit (battery or gas engine), hydraulic lifting, weather protection.	High	YES (3)
PAL lift	Self-propelled unit (gas engine), hydraulic lifting, weather protection.	High	YES (18)
Lift truck	Self-propelled, enclosed cabin lifted hydraulically, weather protection.	High	YES (1)
DEW bridge	Self-propelled bridge, hydraulic lifting, weather protection, integrated with boarding of all passengers.	Very high	NO
APEX bridge	Self-propelled bridge, hydraulic lifting, weather protection, integrated with boarding of all passengers.	Very high	NO

NOTES: Price Range: Low (CAN$400 - $1,000); Medium (CAN$3,000 - $4,000); High (CAN$20,000 - $40,000); Very High (CAN$150,000+). Number of airports in the survey: 62.

- ***Portable stair climber***

  This device is a portable, battery-powered frame, to which a wheelchair is connected with its wheels off the ground. The unit moves on two rubber tracks, similar to those of a tank, up and down stairs. The movement is controlled by one agent. The unit has no weather protection for the passenger. This product is available on the market but was not found in use in surveyed airports. The cost is about CAN$3,000 to $4,000.

- ***Ramps***

  Ramps are a technology that provides a means of overcoming the height difference between the ground and the aircraft door level via a lengthy inclined gangway. All passengers, including those using a wheelchair, scooter or other mobility aids, can use ramps. However, if the aircraft door level is relatively high, the inclination of the ramp may be quite steep and substantial physical effort may be required to push a wheelchair up the ramp. These devices were not used in the airports surveyed.

  Some ramps are covered to protect against rain and excessive sun, but they cannot protect against extreme temperatures. Ramps cost about CAN$30,000 - $40,000.

- ***Mechanical lifts***

  Six types of mechanical lifts were identified in the market of boarding devices for small aircraft. All of these types were used in the surveyed airports.

  Two types of mechanical lifts are available. One type is manually cranked to lift a platform with a passenger in a chair from ground level to aircraft doorsill level with a short bridging part to cover the gap between the platform and the aircraft's vestibule. The other type is a powered unit that lifts the platform by means of a small gas engine or battery power.

  Both types are movable and are designed to be moved from storage to the aircraft either by power or pushed/pulled manually. This attribute may make boarding a person with a disability quite "visible" to other passengers as no one else can enter or leave the aircraft until the equipment has been moved

away. This could perhaps also lead to some delays in aircraft departure. Although the manufacturers indicate that it takes just a few minutes to prepare and perform the boarding procedures, some air carriers and/or airports indicated longer times, and one air carrier indicated that a lift device is more difficult to set up with certain aircraft types than with others.

Lifts can provide access to the door of the aircraft but the use of a narrow chair is still required to move the passenger to his/her seat in the aircraft. Two "chair" transfers are thus required, from passenger's own chair to the narrow chair and then from the narrow chair to the aircraft seat. Some lifts provide protection to the passenger against inclement weather. Manufacturers of lifts also indicated that the equipment can operate in a wide range of weather conditions (up to –29° C) and can be stored outside.

The lift devices can be fairly expensive with prices in the range from CAN$20,000 to $40,000.

- ***Low-level loading bridge***

  Bridges are enclosed units that connect the terminal with the aircraft. A special low-level loading bridge for small aircraft was developed in Canada for the Transportation Development Centre to provide integrated, not segregated boarding. The unit is height adjustable to the required aircraft door level, fully protects against inclement weather conditions and can be heated/air conditioned. The cost is over CAN$150,000.

5.1.2 Compatibility with Aircraft

As there are over 20 different types of small aircraft used in Canada, compatibility of boarding devices with a particular aircraft can be a potential problem. For lifting devices, ramps and bridges, compatibility of a device with a particular aircraft type means that the device provides a safe access to the aircraft door (i.e. the device can be raised to the aircraft door and the passenger can pass through the aircraft door). However, since a boarding or transfer chair has to be used to move a passenger from the aircraft vestibule to his/her seat in the aircraft, accessibility of a particular aircraft is also dependent on the compatibility of boarding/transfer chairs with particular aircraft.

Table 5-2 provides information on compatibility of stair climbers, lifts, ramps, and bridges with most frequently used aircraft. This information was compiled from surveys as well as additional research. Compatibility of boarding and transfer chairs with selected most frequently used aircraft is discussed next.

Table 5-2: Compatibility of Lift Devices with Most Frequently Used Small Aircraft (Compatibility with Aircraft Door)

AIRCRAFT	Stair-Trac	Turbo ramp	Platf .lift	Mobi-lift	Lift truck	Just Mobility Lift	PAL lift	Lift-a-loft	DEW bridge	APEX bridge
Dash8-100	C	C	C	C	NC	C	C	C	C	NC
Dash8-300	C	C	NC	C	NC	NC	C	C	C	NC
Beech 1900	C	C	NC	C	NC	C	C	C	NC	NC
Fokker28	C	C	C	C	NC	NC	C	C	C	C
EMB 120	C	C	NC	C	NC	C	C	C	C	NC
EMB 135	C	C	NC	C	NC	NC	C	C	C	C
BA 146	C	C	NC	C	NC	NC	C	C	C	C
ATR 42	C	C	NC	C	NC	NC	C	C	C	C
CRJ 50	C	C	C	C	NC	C	C	C	C	C
Saab 340	C	C	NC	C	C	NC	C	C	C	NC
Jestream31	C	C	NC	C	NC	NC	C	C	NC	NC
HS 142	C	C	C	C	NC	NC	C	C	NC	NC
HS 748	C	C	NC	C	C	C	C	C	NC	NC
Shorts 360	C	C	NC	C	NC	NC	C	C	NC	NC
Metro SW4	C	C	NC	C	NC	NC	C	C	NC	NC
Metro III	C	C	NC	C	NC	NC	C	C	NC	NC
Dornier 328	C	C	NC	C	NC	NC	C	C	C	NC

NOTE: Compatibility information coding: C – compatible; NC – incompatible

Analysis of Table 5-2 indicates that:

- Stair climber is compatible with all aircraft types (according to the manufacturer);
- Three lift models identified in the survey are compatible with all aircraft types, and three other models are compatible with a few frequently used aircraft type;
- Ramp device is compatible with all aircraft types (according to the manufacturer); and
- Two models of boarding bridges are compatible only with some small aircraft. The DEW bridge is relatively flexible and is compatible with a relatively wide range of aircraft. In contrast, the APEX bridge is compatible with only five aircraft types.

Incompatibility of boarding equipment can arise for a number of reasons. For example, it may be impossible to adjust the platform of a lift device exactly to the level of the aircraft door. Low-level boarding bridges are incompatible with a number of aircraft due to the construction of the aircraft (e.g. type and locations of the engines) and the operational constraints of the bridge itself.

5.1.3 Evaluation of Operational Features and Effectiveness

The survey asked carriers and airports to evaluate the operational characteristics of the boarding equipment that they had at their disposal. The following features were considered:

- Technical performance;
- Exposure of passenger to inclement weather;
- Ease of set-up and operation;
- Integration with general boarding;
- Staff and passenger safety; and
- Passenger dignity (safety, protection against inclement weather).

The evaluation used scores from 1 to 3, where 1 stands for not satisfactory performance, 2 for satisfactory performance, and 3 for very good performance.

The survey showed that in general, the equipment is rated as satisfactory and very good with respect to all factors considered. Only a few carriers were not satisfied with the mechanical lifts that they were using or indicated that the

equipment was not satisfactory in terms of integration with general boarding and passenger dignity.

The positive evaluation of performance may well be due to the good quality and design of most of the equipment and good training of staff operating it. But it may also be due to poor understanding of the needs of persons with a disability by air carrier staff.

For all boarding devices in the survey, the boarding procedure for passengers using a mobility aid is typically such that they are first in at departure and last off at arrival. While boarding aircraft first is in general desirable by many passengers, disembarking last is not. Passengers with a disability may thus feel some resentment that they have to wait in the airplane until everybody gets off.

Moving the passenger between the terminal and the aircraft door and between the aircraft door and the seat in the aircraft takes place according to certain procedures or "protocols". Some of the possible protocols are described in Table 5-3 and 5-4.

Table 5-3: Departure Protocols

PROTOCOL	DESCRIPTION
Departure Protocol 1	• Wheelchair transfer in terminal (from own to narrow chair) • Level change in narrow chair • Transfer from narrow chair to aircraft seat
Departure Protocol 2	• Use of passenger's own chair from terminal to level change device • Level change in own chair • Wheelchair transfer in aircraft vestibule (from own to narrow chair) • Transfer from narrow chair to aircraft seat
Departure Protocol 3	• Use of passenger's own chair from terminal to level change device • Level change in own chair • Transfer from own chair to aircraft seat

Table 5-4: Arrival Protocols

PROTOCOL	DESCRIPTION
Arrival Protocol 1	• Transfer from aircraft seat to narrow chair • Level change in narrow chair • Transfer from narrow chair to own chair in terminal
Arrival Protocol 2	• Transfer from aircraft seat to own chair • Level change in own chair • Use of own chair to terminal
Arrival Protocol 3	• Transfer from aircraft seat to narrow chair • Transfer from narrow chair to own chair in aircraft vestibule • Level change in own wheelchair • Use of own chair to terminal

Survey results indicate that in the vast majority of airports Departure Protocol 1 is used in 90 to 100 percent of boardings and Arrival Protocol 1 is used in 90 to 100 percent of disembarkations.

Thus in typical situations, when a passenger using a mobility aid is boarded onto a small aircraft, there are at least two transfers of the passenger between his/her wheelchair and the seat in the aircraft. The narrow chair, such as the Washington chair, has to be used even with more technically advanced boarding technologies such as a mechanical lift or a bridge. This is because the aisles in small aircraft are very narrow, narrower than a typical wheelchair. The entrance vestibule is also very small and narrow and not suitable for transferring a passenger in a wheelchair.

Table 5-5 gives a summary evaluation of the effectiveness and operational features of boarding equipment in terms of:

- Number of transfers required (i.e. transfers between passenger's own wheelchair, airline boarding or transfer chairs, and seat in aircraft);
- Means of moving the passenger to the aircraft door (for example, manual carrying of the passenger in chair by airline agents, mechanical lifting);

- Integration of boarding procedures with general boarding; and
- Protection of the passenger against inclement weather.

Table 5-5: Summary Evaluation of Effectiveness and Operational Features of Stair Climbers, Ramps, Lifts and Bridges

EQUIPMENT TYPE	NUMBER OF TRANSFERS	MOVING PASSENGER TO AIRCRAFT DOOR	INTEGRATION WITH GENERAL BOARDING	PASSENGER PROTECTED AGAINST WEATHER
Mobilift	2	Mechanical lifting	NO	NO
Just Mob. Lift	2	Mechanical lifting	NO	NO
Elevator platform	2	Mechanical lifting	NO	YES
Lift-a-loft	2	Mechanical lifting	NO	YES
PAL lift	2	Mechanical lifting	NO	YES
Lift truck	2	Mechanical lifting	NO	YES
DEW bridge	2	Pushing along ramp	YES	YES
APEX bridge	2	Pushing along ramp	YES	YES
Turbo ramp	2	Pushing along ramp	YES	YES
Stair trac	2	Mechanical lifting	NO	NO

The first two evaluation criteria in Table 5.4 affect the comfort of the passenger as well as the safety of the passenger and the agents. The third and the fourth factors, protection against inclement weather and integration with general boarding, are important to passengers using a mobility aid as they provide a sense of security and dignity.

Table 5-5 shows that ramps and boarding bridges have all the advantages of lifts (no manual lifting or pulling passenger in chair, protection against weather). In addition, these devices allow for integration with general boarding as able-bodied passengers also use them. It should be noted, however, that in the case of simple ramps, such as the Turbo ramp, pushing a passenger along

the ramp might still require significant physical effort if the slope of the ramp raised to the aircraft door is fairly steep. Also, both of these devices require two transfers of the passenger, from wheelchair to narrow boarding chair and then again from the narrow chair to the seat in the aircraft. Because of this requirement, boarding using even the most technically advanced devices may still leave a lot of room for improvement.

Thus using the four effectiveness criteria considered in Table 5.4, bridges are rated as the most effective boarding device.

5.2 Boarding Chairs and Transfer Chairs

Surveys of airports and air carriers as well as additional research conducted in the second part of the project identified the following types of boarding and transfer chairs:

- Washington;
- Columbia;
- Manten;
- E & J;
- Aviator
- Seat Case;
- Wiltshire;
- Just Mobility;
- Invacare; and
- Norton.

The Seat Case, Invacare, Wiltshire, and Just Mobility chairs are typical transfer and on-board chairs, i.e. they are primarily intended for moving the passenger inside the aircraft. They do not seem to be designed for the carrying of a passenger up and down aircraft stairs and thus cannot be used for the "level change" procedure.

The following sub-sections present the results of the survey and analysis discussing operational characteristics, compatibility with small aircraft, and effectiveness.

5.2.1 Description and Operational Characteristics

Table 5-6 provides a summary description of the operational characteristics of boarding and transfer chairs, and Table 5-7 shows the price range and the use of the chairs in the airports surveyed. A brief description of each chair type follows after the tables.

Table 5-6: Summary Description of Boarding and Transfer Chairs

TYPE	WIDTH AT SEAT LEVEL	FRAME	ARM-RESTS	FOOT-REST	STRUCTURE	REAR WHEELS	FRONT WHEELS	BELTS	BRAKES
Washington	37 cm (14.6 in)	Fixed	None	Fixed with frame	Aluminum tubing	2	None	Lap, shoulder leg	None
Columbia	33 cm (13 in)	Foldable	Pivoting	Fixed with frame	Steel tubing	2	2	Lap, shoulder, leg	Deadman
Manten	38 cm (15 in)	Fixed	Pivoting	Foot plates	Round tubing	2	2	Lap	Rear
E & J	38 cm (15 in)	Foldable	Removable	Foot plates	Round steel tubing	2	2	Lap	Rear
Aviator Aisle lift	39.3 cm (15.5 in)	Lifts seat to 71 cm	Pivoting	Fixed	Aluminum	2	2	None	Rear
Aviator Aisle Ease	39.3 cm (15.5 in)	Fixed	Pivoting	Fixed	Aluminum	2	2	None	Rear
Aviator Lite	36.8 (14.5 in)	Fixed	None	Fixed	Aluminum	2	None	Lap, shoulder	None
Seat Case	36.8 cm (14.5 in)	Plastic and metal	Fixed	Tubing frame	Steel and molded plastic	2	2	Lap, leg	Foot pedal rear

Table 5-6: Summary Description of Boarding and Transfer Chairs (continued)

TYPE	WIDTH AT SEAT LEVEL	FRAME	ARM-RESTS	FOOT-REST	STRUCTURE	REAR WHEELS	FRONT WHEELS	BELTS	BRAKES
Wiltshire	35.5 cm (14 in)	Foldable	Pivoting	Pull out	Steel				
Just Mobility	28 cm (11 in)	Fixed	None	Pull out	Aluminum	2	2	Lap	Foot brake rear
Invacare	35.5 cm (14 in)	Foldable	Pivoting	Flip up	Aluminum	2 with brakes	2	NA	On rear casters
Norton	34.3 cm (13.5 in)		Folding			2	2		On rear

NOTE: * The Seat Case, Invacare, Wiltshire, and Just Mobility chair are typical on-board chairs and do not seem to be designed for the carrying of a passenger up and down stairs.

Table 5-7: Boarding and Transfer Chairs: Price Range and Use in Canadian Airports

CHAIR	PRICE RANGE	USED IN THE SURVEY – YES/NO (NO. OF AIRPORTS)
Washington	Low	YES (32)
Columbia	Low	YES (37)
Manten	Low	YES (5)
E&J	Low	YES (6)
Aviator chair	Low	YES (1)
Seat Case	Low	YES (1)
Wiltshire chair	Low	YES (1)
Just Mobility chair	Low	YES (3)
Loading chair	Low	YES (2)
Invacare chair	Low	YES (1)
Norton chair	Low	YES (1)

NOTES: Price Range: Low (CAN$400 - $1,000); Medium (CAN$3,000 - $4,000); High (CAN$20,000 - $40,000); Very High (CAN$150,000+). Total number of airports in the survey: 62.

- **Washington**

The Washington chair has a fixed aluminium frame with a straight high back, head support, and no features to support the body ergonomically. The two rear wheels require the chair to be wheeled in a tipped and uncomfortable position for the passenger. Sitting in the chair for a prolonged period of time is not comfortable for the passenger due to the lack of armrests and ergonomic support of the upper body. The chair's width of 37 cm (14.6 in.) can negotiate the aisles of the most commonly used aircraft, e.g. Dash series, RJ and ATR 42. The handles used to carry the chair are part of the frame and are located on the back upper portion and at the front of the footrest. The high position of the rear handles makes it very difficult for the agent to exert strength when in tight quarters. The chair has shoulder, lap and leg belts to secure the passenger.

- **Columbia**

The Columbia chair has a foldable steel frame with a moulded seat and backrest, a separate headrest and pivoting armrests. It provides ergonomic back and head support and arm support. The chair has four wheels and the passenger is wheeled in a natural sitting position. The chair's width at seat height of 33 cm (13 in.) allows access to the most commonly used aircraft: the Dash series, RJs, the HS 748, the ATR 42 and even the Beechcraft 1900's first row. Two handlebars at the rear and two at the foot rest can be extended for carrying and retracted to reduce the overall length of the chair for easier manoeuvring within an aircraft. The chair has shoulder, lap and leg belts to secure the passenger.

- **Manten**

The Manten chair has a fixed steel frame with removable armrests, pivoting footplates and four wheels. The seat and back are slightly curved and provide basic comfort for the passenger. The passenger can be wheeled in a natural sitting position. The chair has at the rear two fixed extended handlebars that cannot be retracted. The length of the chair cannot be reduced for use in tight quarters. There are no special handlebars at the front, but two cross braces on the frame can be used. This position forces an agent to reach behind the passenger's legs and get close to the passengers legs with his/her upper body, not a comfortable position for carrying. The chair has a lap belt to secure the passenger. The chairs width is 38 cm (15 in.) and can negotiate the aisles of the Dash series and RJs.

- **E&J**

The E&J chair has a steel frame that can be folded laterally. The armrests are removable and support the passenger's arms when in a waiting or wheeled mode. The chair has four wheels so that the passenger can sit in a natural position. At the back there are two extended fixed handlebars, but no specific handlebars at the front. Two foot plates are movable to get in and out of the chair from the front. Cross braces on the frame can be used as handle bars at the front, but their position is behind the passenger's leg, making it difficult for the agent to reach and bringing him/her close to the passenger's legs and in an uncomfortable carrying position. The chair has a lap belt to secure the passenger. The chairs width is 38 cm (15 in.) and can negotiate the aisles of the Dash series and RJs.

- **Aviator Lite**

The Aviator Lite chair is very similar to the Washington chair. It has a high back, a fixed aluminium frame and footrest, and two rear wheels. The chair must be tipped in an uncomfortable position in order to wheel the passenger. The straight seat, back and head support do not provide ergonomic support for the passenger. The chair does not have armrests for support, but fixed rear handlebars at shoulder height allow for better carrying. At the front there are no specific handlebars, an agent must use the footrest frame. The chair has shoulder and lap belts to secure the passenger. The chair's width is 36.8 cm (15.5 in.) and can negotiate the aisles of the Dash series, RJs and the ATR 42.

- **Other Aviator Models**

The company offers several other boarding chair models with a seat that can be lifted so that transfer over the armrest is facilitated. These models have armrests, four wheels, and moulded back and headrest, but their width is 39.4 cm (15.5 in.), therefore not enabling negotiation of the aisle in the Dash series. However, the chair could be used in the Canadair Regional Jet.

- **Seat Case**

The Seat Case chair is designed as an on-board chair that is to be carried on board larger aircraft. Aircraft used on long-distance flights must provide an on-board chair for passengers who cannot walk to a washroom. The chair is therefore designed to be compact and foldable, and take up little stowage room. The seat is rigid plastic with an optional seat cushion, the back is sling fabric, and the foot rest a round tube. The four small wheels can negotiate aircraft interiors, but not exterior surfaces. The chair is not designed to be used for prolonged periods of time, or for carrying a passenger up and down stairs. Investigations would be required to determine whether this chair could be used to carry passengers up and down aircraft stairs. The chair has optional armrests, lap and leg belts. Its width of 36.8 cm (14.5 in.) can negotiate the aisles of the Dash series, Regional Jets and the ATR 42.

- **Just Mobility**[13]

The Just Mobility chair is an on-board chair for use in large aircraft. It is designed to be compact for use within an aircraft. It is the narrowest of all chairs at 28 cm (11 in.); therefore, it is able to negotiate the aisles of the commonly used small aircraft under consideration. The chair has an ergonomically designed seat and low backrest with a special wide wrap around lap belt. The four wheels allow the passenger to remain in a natural sitting position. The footrest is telescoping. The rear handlebars and the front footrest are not specifically designed for carrying a passenger up and down stairs, but to move a passenger within the aircraft. Investigation would be required to determine whether this chair could be used for carrying passengers up and down aircraft stairs.

- **Wiltshire**

Although designed specifically as an on-board chair, the Wiltshire has certain features that allow its use in a terminal or for wheeling over exterior surfaces. As an on-board chair it is vertically foldable, has pivoting armrests and a seat width of 35.5 cm (14 in.), thus allowing passage of aisles of the Dash series, RJs, the HS 748 and the ATR 42.

As a boarding chair it has a telescoping footrest with handlebars at the end. The rear handlebars are foldable at the passenger's shoulder height, reducing the length of the chair when manoeuvring in tight quarters. A set of large rear wheels and oversized front casters allow for its use on exterior surfaces and a natural sitting position of the passenger when wheeled. Seat and back cushion are straight but of high-density foam. The chair has a lap belt and a belt over the upper leg area.

- **Invacare**

The Invacare is designed as an on-board chair, made of round steel with a transverse foldable frame. Seat and back are of a sling fabric design, the armrests pivot, and the footplates flip up. The chair has four small casters, which allow the passenger to remain in a natural seated position. The chair

[13] The Just Mobility chair, however, seems not to be available on the market anymore. We were unable to locate the manufacturer of this chair.

width of 35.5 cm (14 in.) allows for the negotiation of the aisles in the Dash series, RJs, the HS 748 and the ATR 42.

If this chair is to be used as a boarding chair, the sling seat and back are not conducive for accommodating a passenger for a prolonged period of time in a terminal, for instance.

The two rear handlebars are at the passenger's shoulder height. There are no specific handlebars at the front, but the outside supports of the footplates could be used for carrying.

- **Norton**

There is no information on operational characteristics currently available about the Norton chair. This model may have been discontinued or the manufacturer may no longer exist.

5.2.2 Compatibility with Aircraft

Small aircraft are small in many aspects, including narrow stairs, small entrances, small vestibules, short seat pitch, narrow seats, and full standing height only in the centre of the aisle, not above seats.

Under these conditions, there are several factors that can influence compatibility of the various boarding and transfer chairs with the aircraft, including the following:

- Dimensions of aircraft and geometry:
  - stair width,
  - door opening,
  - vestibule depth, width, and height, and
  - aisle width.

  Stair width, door opening and aisle width determine whether the space can be negotiated with a given chair model. Dimensions of the vestibule determine whether a turn into the aisle with a boarding chair and an agent at the rear is possible. Any vestibule depth of less then 1.05 m (part of boarding chair with agent behind and foot portion of chair still in entrance door) and a width of less then 70 cm renders access to the passenger cabin almost impossible.

- Boarding chair characteristics: overall length, width, handlebar position, wheel position, armrest, ergonomic back and headrest. These characteristics determine whether it is possible to manoeuvre the chair in the vestibule and push down the aisle.

- Passenger idiosyncrasies, including weight, height, and width. Passengers who are very tall and overweight may pose additional problems with lifting and manoeuvring.

In the second part of this project, seven aircraft types were selected for a detailed study to determine their compatibility with various chair types. These aircraft included the following (see Section 4.5 for the selection criteria):

- Dash 8-100;
- Dash 8-300;
- Canadair Regional Jet;
- Beechcraft 1900D;
- Metroliner;
- HS 748; and
- ATR 42.

For each aircraft type, measurements were obtained from the manufacturer and other research. All aircraft types were then inspected in person. The Dash 8-100, Dash 8-300, Canadair Regional Jet, Beechcraft 1900D, and Metroliner were inspected in their full operational configuration. The ATR 42 and HS 748 were accessible only in a maintenance centre in a stripped-down configuration with the seats removed.

The collected information was then used to determine the compatibility of the various boarding and transfer chairs with:

- Aircraft stairs and service door;
- Aircraft vestibule; and
- Aircraft aisles.

The analysis of the collected data indicates that:

- All boarding chairs identified are compatible with small aircraft stairs and service door.
- All boarding and transfer chairs are compatible with all small aircraft vestibules, except for Metroliner. The only chair compatible with the vestibule of this aircraft is the Just Mobility chair.

Compatibility with aircraft aisles is shown in Table 5-8.

Table 5-8: Compatibility of Boarding and Transfer Chairs with Selected Aircraft (Compatibility with Aircraft Aisles)

TYPE/ SEAT WIDTH	Dash 8-100 Aisle: 39.4 cm (15.5 in)	Dash 8-300 Aisle: 39.4 cm (15.5 in)	Regional Jet Aisle: 40.6 cm (16 in)	Metroliner Aisle: 31 cm (12.2 in)	HS 748 Aisle: 36.8 cm (14.5 in)	Beechcraft 1900 Aisle: 33 cm (13 in)	ATR 42 Aisle: 38 cm (15 in)
Washington 37 cm (14.6 in)	C	C	C	NC	NC	NC	C
Columbia 33 cm (13 in)	C	C	C	NC	C	Only first row	C
Manten 38 cm (15 in)	C	C	C	NC	NC	NC	NC
E & J 38 cm (15 in)	C	C	C	NC	NC	NC	NC
Aviator Lite 36.8 cm (14.5 in)	C	C	C	NC	NC	NC	C
Seat Case 36.8 cm (14.5 in)	C	C	C	NC	NC	NC	C
Just Mobility 28 cm (11 in)	C	C	C	C	C	C	C
Wiltshire 35.5 cm (14 in)	C	C	C	NC	C	NC	C

Table 5-8: Compatibility of Boarding and Transfer Chairs with Selected Aircraft (Compatibility with Aircraft Aisles) (continued)

TYPE/ SEAT WIDTH	Dash 8-100 Aisle: 39.4 cm (15.5 in)	Dash 8-300 Aisle: 39.4 cm (15.5 in)	Regional Jet Aisle: 40.6 cm (16 in)	Metroliner Aisle: 31 cm (12.2 in)	HS 748 Aisle: 36.8 cm (14.5 in)	Beechcraft 1900 Aisle: 33 cm (13 in)	ATR 42 Aisle: 38 cm (15 in)
Invacare 35.5 cm (14 in)	C	C	C	NC	C	NC	C
Norton 34.3 cm (13.5 in)	C	C	C	NC	C	NC	C

Table 5-8 shows that in general most chairs are compatible with most small aircraft. The Columbia chair is the most versatile chair; it can access all aircraft types except for the Metroliner. The Just Mobility chair is the most universal transfer chair; it is compatible with all aircraft types examined.

There are serious compatibility problems with two aircraft types:

- Metroliner, and
- Beechcraft 1900D.

Specifically, there is no boarding chair compatible with the Metroliner, and only one type of compatible transfer chair, the Just Mobility chair. Since the Just Mobility chair is not designed for carrying the passenger up and down aircraft stairs, the results of the analysis imply that the passenger using a mobility aid can access the Metroliner aircraft only when a boarding lift and the Just Mobility chair are available in the departure and arrival airports.

The Beechcraft 1900D can be accessed only with the Columbia chair and only up to the first row. If access to seats beyond row one is required, the Just Mobility chair has to be used, and hence the same comments regarding accessibility as those for the Metroliner apply here.

In addition, there are some compatibility problems with two aircraft types:

- HS 748, and
- ATR 42.

Both aircraft types are compatible with the Just Mobility chair and the Columbia chair. However, the HS 748 is not compatible with the Washington chair, which is one of the most frequently used chairs in Canadian airports. Moreover, the two aircraft types are incompatible with several other chair types used in the industry.

5.2.3 Evaluation of Operational Features and Effectiveness

Carriers and airports were asked to evaluate the operational characteristics of the boarding chairs that they had at their disposal. As with level change devices, the following features were considered:

- Technical performance;
- Exposure of passenger to inclement weather;
- Ease of set-up and operation;
- Integration with general boarding;
- Staff and passenger safety; and
- Passenger dignity.

The evaluation uses scores from 1 to 3, where 1 stands for not satisfactory performance, 2 for satisfactory performance, and 3 for very good performance.

The survey showed that in general, the equipment is rated as satisfactory and very good with respect to all factors considered. Only a few air carriers evaluated boarding chairs, in particular the Washington chair, as unsatisfactory in terms of passenger/staff safety and passenger dignity. One carrier indicated that the Columbia chair is very "tippy" for pushing the passenger across the tarmac and the three different belts that are used to strap the passenger in make this chair very difficult to use.

The evaluation of boarding chairs as very good in terms of passenger dignity and passenger/staff safety was somewhat unexpected. It may be due to the good training of the staff operating it but it is perhaps also due to poor understanding of the needs of persons with a disability by air carrier staff.

The second part of this project involved a more detailed examination and evaluation of boarding and transfer chairs. This required a more detailed examination and understanding of the boarding procedure itself.

The boarding procedure for a passenger who uses a mobility aid involves transferring the passenger from his/her own chair to a narrow carrier boarding chair either in the terminal or on the tarmac near the aircraft. Very often the passenger must wait for a prolonged period of time in the boarding chair. The passenger will typically be pre-boarded before all other passengers. He/she will be transported from the terminal in the boarding chair to the aircraft and there carried by two agents up the stairs – or be moved by a lift – into the vestibule. In the vestibule the chair must be turned around with the back to the rear of the aircraft and moved into the aisle adjacent to an accessible seat. Two agents typically transfer the passenger from the chair into the seat by lifting simultaneously, one from the rear, the other from the front. For disembarkation the reverse takes place.

A boarding chair must therefore have certain attributes to be used for these procedures. In particular, the boarding chair should:

- Be compatible with key aircraft features (i.e. able to negotiate the stairs, door, vestibule, and aisle of small aircraft);
- Accommodate the passenger safely and comfortably during operations (e.g. have safety features such as belts and brakes);
- Have features that allow two agents to carry the chair up and down aircraft stairs and turn it in the vestibule;
- Have a set of wheels that allows the passenger to be wheeled in a natural sitting position; and
- Have ergonomic features assuring some level of comfort to the passenger during transport and prolonged waiting times, including ergonomically designed seat, back, headrest, and armrests.

In addition, from a carrier point of view, the chair should:

- Be lightweight;
- Support a passenger weight of up to 300 lb.;
- Be easy to clean;
- Require little maintenance;
- Be sturdy, made of durable materials that withstand wear and tear; and
- Be inexpensive.

All chairs were thus analyzed and evaluated according to their key operational features, including the following:

- Safety features: availability of brakes, belts, front and rear wheels. Brakes are an important safety feature, as they make sure that the chair will not move when it is not supposed to. Belts allow securing the passenger in the chair. Some chairs have a few belts, including lap, shoulder, and leg; other chairs have only one type of belt or none. Wheelchairs with both front and rear wheels can be considered better than those with only rear wheels. Lack of front wheels may create safety problems and discomfort for the passenger as the chair has to be tipped to move. On the other hand, the presence of both front and rear wheels allows for moving the passenger in a natural sitting position.

- Ergonomic features: availability of armrests, design of seat and back, overall comfort. Armrests provide support for the arms increasing the level of comfort for certain types of disabilities or when the passenger has to wait for service for a longer time. An ergonomic design of seat and back makes the chair more comfortable for the passenger.

- Ease of operation: features of the chair that make the operation of it easier to the carrier agents. For example, some chairs have handlebars for pushing by attendant located very high at the back of the chair. This requires substantial strength to operate in tight quarters.

- Other important features, including low weight.

The results of this analysis are shown in Table 5-9.

Table 5-10 shows the evaluation of effectiveness of boarding and transfer chairs in the same terms as level change devices discussed in Section 5.1, i.e. number of transfers required, means of moving the passenger to aircraft door, integration of boarding procedures with general boarding, and protection of the passenger against inclement weather.

Table 5-9: Evaluation of Boarding and Transport Chairs in Terms of Their Key Operational Features

TYPE OF CHAIR	SAFETY FEATURES	ERGONOMIC FEATURES	EASE OF OPERATION	OTHER	OVERALL COMMENTS
Washington	Lap, shoulder and leg belts. No front wheels. No brakes.	No armrests. Straight back without ergonomic shape or features. Chair is very uncomfortable for the passenger.	Rear handles very high. Requires substantial strength to operate in tight quarters.	Light weight, low price.	Basic boarding chair. May be considered "undignified" due to its poor ergonomic features.
Columbia	Lap, shoulder and leg belts. Front and rear wheels. Deadman brakes.	Ergonomic seat, back and head support. Support for the arms. Passenger can be transported in regular sitting position.	Movable handlebars facilitate manoeuvring within an aircraft.	Heavier frame than the Washington.	More modern design, more comfortable and easier to operate compared to the Washington.
Manten	Lap belt. Front and rear wheels. Rear brake.	Seat and back provide basic comfort. Passenger can be transported in regular sitting position.	No handlebars at the front make operation of the chair difficult for carrier agents.		Dated design, somewhat more comfortable than the Washington.

Table 5-9: Evaluation of Boarding and Transport Chairs in Terms of Their Key Operational Features (continued)

TYPE OF CHAIR	SAFETY FEATURES	ERGONOMIC FEATURES	EASE OF OPERATION	OTHER	OVERALL COMMENTS
E & J	Lap belt. Front and rear wheels. Rear brake.	Removable armrests. Sling back and seat provide only basic comfort. Passenger can be transported in regular sitting position.	No handlebars at the front make operation of the chair difficult for carrier agents.		Dated design, somewhat more comfortable than the Washington.
Aviator Lite	Shoulder and lap belts. No brakes. No front wheels.	No armrests. Straight back without ergonomic shape or features.	Difficult to operate due to lack of handlebars at the front.		Derivate of the Washington chair.
Seat Case	Lap and leg belts. Front and rear wheels. Rear brake (foot pedal).	Optional armrest. Sling back, flat seat, seat cushion optional.		Typical on-board chair for use in larger aircraft. Not designed for sitting in for long periods of time.	Provides basic comfort to the passenger.

Table 5-9: Evaluation of Boarding and Transport Chairs in Terms of Their Key Operational Features (continued)

TYPE OF CHAIR	SAFETY FEATURES	ERGONOMIC FEATURES	EASE OF OPERATION	OTHER	OVERALL COMMENTS
Just Mobility	Wide Velcro lap belt. Front and rear wheels. Rear brake (foot pedal).	No armrests.		Typical on-board chair for use in larger aircraft. Very narrow, compatible with most small aircraft but uncomfortable for passengers with larger waist dimensions.	Compatible with all aircraft examined. Can be seen as uncomfortable due to lack of armrests and narrow size.
Wiltshire	Shoulder, lap and leg belts.	Folding armrests provide arm support. Passenger can be transported in regular sitting position.	Folding handlebars front and rear allow for tight manoeuvring.	Typical on-board chair for larger aircraft. Can also be used as a terminal chair.	Provides basic comfort to the passenger.
Invacare	No belts. Front and rear wheels. Brake on rear wheels.	Folding armrests. Sling seat and back, not comfortable when sitting for a long period of time.			Provides limited comfort. Some passengers may be unsafe due to lack of safety belts.

Table 5-10 Evaluation of Effectiveness of Boarding Chairs

CHAIR TYPE	NUMBER OF TRANSFERS	MOVING PASSENGER TO AIRCRAFT DOOR	INTEGRATION WITH THE GENERAL BOARDING	PROTECTION AGAINST WEATHER
Washington	2	Manual carrying up the stairs.	NO	NO
Columbia	2	Manual carrying up the stairs.	NO	NO
E & J	2	Manual carrying up the stairs.	NO	NO
Manten	2	Manual carrying up the stairs.	NO	NO
Just Mobility Chair	2	Manual carrying up the stairs.	NO	NO
Aviator Lite	2	Manual carrying up the stairs.	NO	NO
Wiltshire	2	Manual carrying up the stairs.	NO	NO
Invacare	2	Manual carrying up the stairs.	NO	NO
Norton	2	Manual carrying up the stairs.	NO	NO
Seat Case	2	Manual carrying up the stairs.	NO	NO

Table 5-9 suggests that one of the better boarding chairs available in the industry today in terms of safety, ergonomic features and ease of operation for carrier agents is the Columbia chair. In terms of features taken into account, it is better than the commonly used Washington chair and it seems to be better than several other types of chairs.

The Just Mobility chair – although not designed as a boarding chair and uncomfortable to the passenger to some extent – can be considered a

"desirable" piece of equipment due to its compatibility with all small aircraft types typically used in Canada

Table 5-10 shows that boarding chairs in general require manual carrying of the passenger up and down the stairs as well as lifting the passenger for transfers from his/her own wheelchair to the narrow boarding chair and then from the narrow chair to the seat in the aircraft. These two transfers are necessary as aisles in aircraft are very narrow and can only be accessed with narrow carrier chairs. Boarding chairs do not provide protection against weather and do not allow for integrated boarding.

6: SURVEY RESULTS AND ANALYSIS: USE OF BOARDING DEVICES IN CANADIAN AIRPORTS

The returned surveys of air carriers and/or airports provided information on boarding devices for 62 different airports. Table 6-1 shows the list of these airports. All of these airports are used in the analysis of the availability and use of boarding equipment for small aircraft. The classification of airports into large, medium, and small airports is based on the number of daily departures of small aircraft with 19 to 60 passenger seats indicated by the OAG database.[14]

Table 6-1: List of Airports in the Database with Information on Boarding Devices Used

AIRPORT NAME	DEPARTURES PER DAY (OAG)
Large airports	
Toronto Lester B. Pearson	211
Vancouver	166
Dorval	163
Quebec City Jean Lesage	72
Winnipeg	65
Halifax	62
Medium airports	
Victoria	34
Thunder Bay	32
Regina	30
Goose Bay	30

[14] A breakdown into airport size group according to passenger traffic may be more desirable from the policy point of view. Statistics Canada was approached regarding obtaining data on passenger traffic. The data on total passenger traffic for large airports can be easily obtained from annual Statistics Canada publications. However, data for small airports are considered confidential.

Table 6-1: List of Airports in the Database with Information on Boarding Devices Used (continued)

AIRPORT NAME	DEPARTURES PER DAY (OAG)
Sept-Iles	26
Thompson	24
Saint John	21
Kelowna	20
Small airports	
St. John's	22
Windsor	18
Fredericton	18
Timmins	16
Sault Ste. Marie	15
Prince George	15
Val d'Or	14
Sydney	12
Deer Lake	12
Wabush	11
Charlottetown	11
Kingston	11
Baie Comeau	11
Kamloops	11
Gander	10
Rouyn-Noranda	9
Pakuashipi	9
Bagotville	9
Moncton	8
Waskaganish	7
Moosonee	6

Table 6-1: List of Airports in the Database with Information on Boarding Devices Used (continued)

AIRPORT NAME	DEPARTURES PER DAY (OAG)
Attawaspuskat	6
Kashechewan	6
Fort Albany	6
Flin-Flon	5
Chisasibi	4
Forth Smith	4
Peawanuck	4
Bathurst	4
East Main	4
Wemindji	4
Chibougamau	3
La Grande	3
Williams Lake	3
High Level	2
Prince Rupert	2
St. Leonard	2
Yarmouth	1
Fort Frances	1
Roberval	1
North Peace	n/a
Charlo	n/a
Miramichi	n/a
Kapuskasing	n/a
Hearst	n/a
Cassidy	n/a
Fort McMurray	n/a

NOTE TO TABLE 6-1: Entry "n/a" in the Departures per Day column shows airports where – according to the OAG – there were no flights on small aircraft with 19 to 60 passenger seats. However, these airports filled out a copy of the survey and are thus included in the analysis.

Table 6-1 shows that the sample includes some of the largest Canadian airports, a few medium-sized airports, and a wide range of small airports, giving as a result a fairly balanced sample of airports. This makes survey results statistically significant and allows projecting survey findings on all airports in Canada.

In this section, we discuss the availability, use, and ownership of boarding devices in airports surveyed.

6.1 Availability and Use of Boarding Devices in Airports of Various Sizes

The survey results showed that each airport surveyed has a boarding device, at least a boarding chair. Table 6-2 summarizes the results on the availability of various boarding devices.

Table 6-2: Availability of Boarding Devices

DEVICE	PERCENTAGE OF AIRPORTS USING	DEVICE	PERCENTAGE OF AIRPORTS USING
Washington	52%	Wiltshire chair	1.6%
Columbia	60%	Seat Case	1.6%
E&J	10%	Mobilift	8%
Manten	8%	Just Mobility lift	1.6%
Just Mobility chair	4.8%	Elevator platform	1.6%
Aviator chair	1.6%	Lift-a-loft	4.8%
Loading chair	3.4%	PAL lift	29%
Invacare chair	1.6%	Lift truck	1.6%
Norton chair	1.6%		

As Table 6-2 demonstrates, boarding chairs, and in particular the Columbia chair and the Washington chair, are the most common boarding devices. Some airports have multiple devices: two or three types of boarding chairs, and up to two lift devices.

Airports that have a lift device also have a boarding chair; as explained earlier, boarding chairs must still be used with lifts, ramps and bridges to move the passenger from the aircraft door to his/her seat in aircraft.

Table 6-3 shows the frequency with which the boarding equipment was deployed during a typical month broken down by airport size. The table shows several answers on the range of frequency with which the equipment was used in various airports rather than an average for each airport size. (Note that the sum of responses in each row does not give the number of airports in the size group as not all of the returned surveys provided an answer to this question.)

Table 6-3: Frequency of Deployment of Boarding Devices in Airports of Various Sizes (Examples of Number of Times During a Typical Month)

AIRPORT SIZE	AIRPORTS WITH ONLY BOARDING CHAIR	AIRPORTS WITH BOARDING CHAIR AND MECHANICAL LIFT
Large (50+ departures per day) 6 Airports	0-5	30-40; 15-20; 30-45
Medium (20 – 50 departures per day) 8 Airports	2; 5-10	0; 10-30; 50-95
Small (Fewer than 20 departures per day) 48 Airports	6; 0; 5; 2; 10; 0; 1; 1; 0; 0; 5-15; 5; 1-5;0; 0; 0	10; 0; 10; 6; 10-15; 1-5; 30; 4; 5-15; 5-15; 1-10; 2-8; 2-3; 30-60; 20; 1

Table 6-3 shows that many small airports use boarding equipment for small aircraft less than once a month. But the pattern of use of the boarding devices for small aircraft that emerges from Table 6-3 is more complex. The table shows that the use of the equipment is <u>not</u> strongly related to airport size. The largest airports would likely have the largest average frequency of use.

However, it was a medium airport that reported the largest frequency of equipment deployment (Thunder Bay, 50-95 times a month) and a small airport that reported the second largest frequency of deployment (Moncton, 30-60 times a month).

These results suggest that many smaller airports may be dealing with a larger number of passengers with a disability than larger airports. Thus improvements at some of these airports may be even more pressing than improvements at large airports.

6.2 Availability of Compatible Boarding Devices in Airports of Various Sizes

Although each of the airports in our sample had some type of boarding equipment for passengers using a mobility aid, an important question that arose is whether these devices are compatible with all small aircraft that use that airport.

The compatibility of each device in each airport was thus checked against small aircraft using that airport to determine whether some types of aircraft have no compatible boarding device. Since lifting devices require the use of a boarding or transfer chair to move the passenger from the aircraft door to his/her seat, this involved two steps:

1. Checking the compatibility of level change devices, including lifts and boarding chairs, available in the given airport against aircraft types using that airport (i.e. checking compatibility of these devices with aircraft door); and

2. Checking the compatibility of the boarding and transfer chairs available in that airport against aircraft types using that airport (i.e. checking compatibility of boarding and transfer chairs with aircraft aisles).

The first step was one of the objectives of the first stage of this project and survey instruments were used to collect this information. The second step was the focus of the second phase of this project in which aisle and seating accessibility were examined in detail for seven aircraft types (see section 4.5) through research as well as aircraft inspections and boarding demonstrations.

The analysis of collected survey data revealed that for all airports surveyed, all level change devices available in a particular airport are compatible with all aircraft types using that airport.

However, compatibility of boarding and transfer chairs with aircraft aisles is a potential problem. Survey and OAG data indicate that the majority of airports surveyed (about 60 percent) serve one or more of the following aircraft types:

- Beechcraft 1900D;
- Metroliner;
- HS 748; and
- ATR 42.

As reported in section 5.2, the second phase of this project revealed that compatibility of boarding and transfer chairs with aisles in these aircraft types is a potential problem, i.e. only some chairs are compatible with these aircraft. In the surveys of airports and air carriers, only three airports reported having the Just Mobility transfer chair, the most versatile chair compatible with all aircraft types, and some but not all airports had the Columbia chair, which provides access to the HS 748, ATR 42 and the first row in the Beechcraft 1900D. The remaining airports had only the Washington chair and other types of chairs that are not compatible with the above aircraft. Table 6-4 gives the detailed results of compatibility analysis.

Table 6-4: Availability of Compatible Level-Change Devices / Boarding and Transfer Chair Combinations in Airports of Various Sizes

AIRPORT SIZE	AIRPORTS WITH FULLY COMPATIBLE COMBINATIONS FOR ALL AIRCRAFT	AIRPORTS WITH AT LEAST PARTIALLY COMPATIBLE COMBINATIONS FOR ALL AIRCRAFT	AIRPORTS WITH NO COMPATIBLE COMBINATIONS FOR SOME AIRCRAFT
Large (50+ departures per day) 6 Airports	1 (16.7%)	2 (33.3%)	4 (66.7%)
Medium (20 – 50 departures per day) 8 Airports	4 (50%)	6 (75%)	2 (25%)
Small (Fewer than 20 departures per day) 48 Airports	22 (45.8%)	25 (52.1%)	23 (47.9%)
All Airports 62 Airports	**27 (43.5%)**	**33 (53.2%)**	**29 (46.7%)**

NOTE TO TABLE 6-4: Airports with fully compatible combinations of level-change devices and boarding/transfer chairs include airports where level-change devices are compatible with aircraft doors of all aircraft types served in that airport, and boarding and transfer chairs are compatible with the aisles of aircraft selected for detailed study in the second phase and served in that airport. Airports with at least partially compatible combinations of level-change devices and boarding/transfer chairs include airports with fully compatible combinations plus airports serving Beech 1900D and reporting to have the Columbia boarding chair. (As reported in Section 5.2, the first row in Beech 1900D can be accessed with the Columbia chair but not rows two and up.)

As shown in Table 6-4, some incompatibilities of aircraft and boarding devices do exist in Canadian airports. Although there were no airports in the sample where all aircraft types served were incompatible with boarding equipment, 46.7 percent of airports served an aircraft type for which there is no compatible combination of level-change devices/boarding and transfer chairs in that airport.

These incompatibilities are solely due to lack of boarding and transfer chairs compatible with all aircraft types served in the given airport. Specifically, incompatibilities arise when the airport serves:

- Metroliner and the Just Mobility chair is not available;
- Beechcraft 1900D and the Just Mobility chair or the Columbia chair are not available; and
- HS 748 or ATR 42 and the Columbia chair or the Just Mobility chair (or a few other types of chairs) are not available.

The identified "problem" aircraft types accounted in early 2002 for about 18 percent of total flight volume (see section 4.5 and Table 4-17) creating the possibility that in many airports, some flights are inaccessible to persons using a wheelchair.

6.3 Operation and Ownership of Boarding Devices

The survey results indicated that in the vast majority of airports, boarding devices for small aircraft, both boarding/transfer chairs and mechanical lift devices, are operated by airline staff and owned by air carriers. Only in three airports (4.8 percent of airports) were boarding chairs owned by the airports and only in six airports (9.7 percent of airports) were lift devices owned by the airport authority. All of these airports were from the group of small airports according to the classification used in this section.

In one case, the air carrier owning a lift device was renting it for a fee to other air carriers. In the case of the low-level boarding bridge installed recently in another airport (Kelowna International Airport), the bridge is owned by the city and operated by the airport.

A number of airport officials indicated that the airport authority is responsible for accessibility of the airport terminal and carriers are responsible for boarding of aircraft.

The survey results thus suggest that the current practice is such that the air carrier is expected to purchase boarding devices for its use. Other solutions are also possible but they are rather an exception than truly an alternative method of financing the equipment.

7: AIRCRAFT INSPECTIONS AND ANALYSIS OF PASSENGER CABIN LAYOUT

During the second part of the project, measurements of key aircraft dimensions were collected and aircraft inspected according to the methodology outlined in Section 2. Information from manufacturers on key dimensions was treated as the initial assessment. This was then confirmed by in-person aircraft inspections.

For all aircraft types selected for detailed study, measurements were obtained from the manufacturer and other research. All aircraft types were then inspected in person. The Dash 8-100, Dash 8-300, Canadair Regional Jet, Beechcraft 1900D, and Metroliner were inspected in their full operational configuration. The ATR 42 and HS 748 were accessible only in a maintenance centre in a stripped-down configuration with the seats removed.

This information was then used to assess the accessibility of each aircraft type, including presence of features that make the aircraft more "friendly" to passengers who use a mobility aid and compatibility with boarding chairs.

Table 7-1 provides a summary of analysis of key aircraft features. Appendix H provides pictures of aircraft passenger cabin layout.

Table 7-1: Summary of Key Aircraft Features and Analysis of Passenger Cabin Layout

AIRCRAFT FEATURES	DASH 8-100	DASH 8-300	REGIONAL JET	BEECHCRAFT 1900D	METROLINER	ATR 42	HS 748
Number of seats	37	50	50	18/19	18/19	16-44	20 - 44
Key dimensions							
• Aisle width	39.4 cm	39.4 cm	40.6 cm	29.8 cm	31.1 cm	38 cm	38.1 cm
• Stair width	57.1 cm	57.1 cm	66 cm	48.3 cm	59.7 cm	53.3 cm	63.5 cm
• Vestibule width	71.1 cm	71.1 cm	1.0 m	1.02 m	55.8 cm	81.3 cm	96.5 cm
• Vestibule depth	1.32 m	1.31 m	1.15 m	99 cm	58.4 cm	2.03 m	1.06 m
• Vestibule height	1.65 m	1.65 m	1.83 m	1.79 m	1.44 m	1.89 m	1.85 m
• Cargo door width	1.27 m	1.27 m	1.09 m	1.42 m	1.34 m	1.29 m	1.22 m
• Cargo door height	86.4 cm	86.4 cm	86.4 cm	1.44 m	1.34 m	1.58 m	1.36 m
Armrests fixed (which rows).	First row.	First row.	First row.			Info not available.	Info not available.

Table 7-1: Summary of Key Aircraft Features and Analysis of Passenger Cabin Layout (continued)

AIRCRAFT FEATURES	DASH 8-100	DASH 8-300	REGIONAL JET	BEECHCRAFT 1900D	METROLINER	ATR 42	HS 748
Armrests pivoting (which rows).	All except the front row.	All except the front row.	All except the front row.	All rows.	All rows.	Info not available.	
Accessible washroom (Yes/No).	No	No	No	No	No	No	No
Other key features.	Partial seat fold back.	Partial seat fold back.		Complete seat fold back.		Last row the aisle is wider by 5 cm.	Seat fold back.
Potential accessibility problems (including safety of passenger and carrier agents).	Carrying up and down stairs. Pax transfers.	The same as the Dash 8-100.	The same as the Dash 8-100.	Carrying up and down stairs. Pax transfers. Vestibule very tight.	Carrying up and down stairs. Pax transfers. Vestibule very tight and almost inaccessible.	The same as the Dash 8-100.	The same as the Dash 8-100.

Table 7-1: Summary of Key Aircraft Features and Analysis of Passenger Cabin Layout (continued)

AIRCRAFT FEATURES	DASH 8-100	DASH 8-300	REGIONAL JET	BEECHCRAFT 1900D	METROLINER	ATR 42	HS 748
Carrier policy with respect to front row and exit seating.*	No seating near entrance or emergency exits for passengers with mobility impairments. Most passengers with disabilities, mothers with infant, and seniors request front row. Advance booking and first come,	The same as the Dash 8-100.	The same as the Dash 8-100.	The same as the Dash 8-100.	Despite regulations, passengers using mobility aids are allowed to be seated near the entrance door, this being the only accessible seat.	The same as the Dash 8-100.	The same as the Dash 8-100.

Table 7-1: Summary of Key Aircraft Features and Analysis of Passenger Cabin Layout (continued)

AIRCRAFT FEATURES	DASH 8-100	DASH 8-300	REGIONAL JET	BEECHCRAFT 1900D	METROLINER	ATR 42	HS 748
	first served apply.						
Carrier policy with respect to boarding and disembarkation.*	First on, last off.	The same as the Dash 8-100.	The same as the Dash 8-100.	The same as the Dash 8-100.	The same as the Dash 8-100.	The same as the Dash 8-100.	The same as the Dash 8-100.

NOTES: * All major Canadian carriers have the same policies.

As Table 7-1 demonstrates, small aircraft are small in many aspects, including narrow stairs, small entrances, small vestibules, short seat pitch, narrower seats, full standing height only in centre of aisle, not above seats, reduced washroom dimensions, limited cargo volume, and limited or no on-board service depending on the number of seats.

Under these conditions, there are several factors that can influence accessibility of the aircraft to a passenger who is mobility impaired and has to be transferred to a narrow boarding chair to board/de-board small aircraft, including the following:

- Dimensions of aircraft and geometry:

    - stair width,
    - door opening,
    - vestibule depth, width, and height, and
    - aisle width.

    Stair width, door opening and aisle width determine whether the space can be negotiated with a given chair model. Dimensions of the vestibule determine whether a turn into the aisle with a boarding chair and an agent at the rear is possible. Any vestibule depth less then 1.05 m (part of boarding chair with agent behind and foot portion of chair still in entrance door) and a width less then 70 cm render access to the passenger cabin almost impossible.

- Boarding chair characteristics: overall length, width, handlebar position, wheel position, armrest, ergonomic back and headrest. These characteristics determine whether it is possible to manoeuvre the chair in the vestibule and push down the aisle.

- Passenger idiosyncrasies: type of disability, weight, height, and width. Some types of disabilities leave individuals with very little body strength, making them very inert and difficult to lift. Moreover, passengers who are very tall or overweight may pose additional problems with lifting and manoeuvring.

- Agent's capabilities: physical strength and training.

- Agent's transfer techniques versus passengers requested techniques.

The first two factors determine the compatibility of boarding and transfer chairs with small aircraft. Boarding and transfer chairs' compatibility with aircraft stairs, service door, vestibule and aisles are discussed in detail in section 5. The main findings were that:

- All boarding chairs are compatible with small aircraft stairs and service doors;
- All boarding chairs are compatible with all small aircraft vestibules, except for the Metroliner;
- Most boarding and transfer chairs are compatible with most small aircraft aisles;
- There are serious aisle compatibility problems with the Metroliner and the Beechcraft.

8: RESULTS OF LIVE BOARDING DEMONSTRATIONS

Live boarding/disembarkation demonstrations were carried out according to the methodology outlined in Section 2 for the following aircraft types:

- De Havilland DHC-8, or Dash 8-100;
- Canadair Regional Jet (CRJ);
- Fairchild Metroliner; and
- Beechcraft 1900D.

Demonstrations on the Dash 8-300 were not deemed necessary as this aircraft model differs from the Dash 8-100 model only by its length and the number of seats. All features affecting accessibility to persons using a mobility aid are the same on both aircraft types. Thus, any conclusions regarding the accessibility of the Dash 8-100 carry over to Dash 8-300.

Demonstrations with the HS 748 and the ATR 42 were not possible as these aircraft types could only be examined in a maintenance centre, which lacked the necessary equipment, facilities and trained staff. In addition, these particular aircraft were in a stripped-down configuration without seats. Accessibility of these aircraft types was evaluated on the basis of key dimension measurements obtained from the manufacturer and other sources. As outlined in the section reporting the results of aircraft inspection and analysis of passenger cabin layout, there are no indications that boarding passengers using a mobility aid would encounter difficulties.

To ensure that the boarding demonstrations were as close as possible to the actual boarding procedure, only trained air carrier agents were used in this exercise. In addition, the subjects participating in the demonstrations with the Dash 8-100, CRJ, and Metroliner were individuals using a mobility aid in their daily life.

Table 8-1 provides a summary of boarding demonstrations for each of the four aircraft types where demonstration was possible. Appendix I provides the details from the demonstrations.

All boarding demonstrations were both photographed and videotaped. Two sample photographs from boarding demonstrations on the Canadian Regional Jet are provided here.

Photo 8-1: Boarding Demonstration on Canadian Regional Jet: Transfer of Passenger to Seat with Moveable Armrest and Transfer to Seat with Fixed Armrest

Table 8-1: Results of Live Boarding Demonstrations

	DASH 8-100	REGIONAL JET (CRJ)	METROLINER	BEECHCRAFT 1900D
Description of subject: Female/Male. Weight with boarding chair. Type of disability.	 Female 63.5 kg (140 lb.) Degenerative rheumatism with limited strength in upper limbs and legs.	 Male 82 kg (180 lb.) Paraplegic with limited strength in upper body.	 Male 113.5 kg (250 lb.) Paraplegic with limited strength in upper body.	 Male 91 kg (200 lb.) None (carrier agent).
Mobility aid used by subject.	Power chair with a headrest and table control.	Sports chair	Power chair	None
Chair used in boarding/deboarding demo.	Columbia	Washington	Columbia	Columbia
Transfer from own chair to boarding chair.	Subject stood up with the help of one agent and transferred into the boarding chair.	Subject transferred by two agents trained in the procedure.	Subject transferred by two agents trained in the procedure.	Subject transferred by two agents trained in the procedure.

Table 8-1: Results of Live Boarding Demonstrations (continued)

	DASH 8-100	REGIONAL JET (CRJ)	METROLINER	BEECHCRAFT 1900D
Transfer to the aircraft door.	Manual. Subject carried head first by two agents trained in the procedure.	Manual. Subject carried head first by two agents trained in the procedure.	Manual. Subject carried head first by two agents trained in the procedure.	Manual. Subject carried head first by two agents trained in the procedure.
Turning in the vestibule into the aisle.	Successful 90 degree turns into the aisle.	Successful 90 degree turns into the aisle.	Agents unable to turn chair into the aisle.	90-degree turn into the aisle was possible although handlebars had to be pivoted into their folded position to reduce the length of chair.
Access to aircraft aisle.	Boarding chair successfully pushed down the aisle.	Boarding chair successfully pushed down the aisle.	Boarding chair could not fit in the aisle. Aisle accessible with the Just Mobility chair.	Only the first seat row is accessible with the Columbia chair. The other seats were accessible with the Just Mobility chair.

Table 8-1: Results of Live Boarding Demonstrations (continued)

	DASH 8-100	REGIONAL JET (CRJ)	METROLINER	BEECHCRAFT 1900D
Transfer from boarding chair to aircraft seat.	One agent lifted from the rear (placing his arms under the subject's shoulder). The second agent lifted from the front (placing his arms under the subject's legs).	One agent lifted from the rear (placing his arms under the subject's shoulder). The second agent lifted from the front (placing his arms under the subject's legs).	Subject lifted and carried by agents into the front seat near the entrance.	One agent lifted from the rear (placing his arms under the subject's shoulder). The second agent lifted from the front (placing his arms under the subject's legs).
Transfer successful? Yes/No (Comments)	Yes Transfer to the satisfaction of subject.	Yes Subject experienced discomfort.	No Structural limitations of the aircraft did not allow for proper boarding. Subject did not always feel safe during boarding.	Yes Due to tight dimensions between the seat and the bulkhead, the agent at the front had difficulties during procedure.

Table 8-1: Results of Live Boarding Demonstrations (continued)

	DASH 8-100	REGIONAL JET	METROLINER	BEECHCRAFT 1900D
Wheelchairs that can be accommodated in cargo compartment.	All common wheelchairs can be accommodated without being disassembled. Batteries may have to be removed.	All typical wheelchairs can be accommodated but those higher than 86.36 cm (34") must be tilted to go through the cargo door. Caution must be exercised when loading and unloading as the left jet engine is mounted close to the door.	All common wheelchairs can be accommodated without being disassembled.	All common wheelchairs can be accommodated without being disassembled. Batteries may have to be removed.
Other.	Seat height of the Dash 8-100 is too high. Subject's feet could not reach floor.	Seat height discrepancy between the Washington chair and the seat does not allow the passenger to slide from the seat to chair easily.		Steps on Beechcraft aircraft not full width as stairs; stance for carrying agent limited.

Table 8-1: Results of Live Boarding Demonstrations (continued)

	DASH 8-100	REGIONAL JET	METROLINER	BEECHCRAFT 1900D
Overall comments.	Considerable physical contact is required during transfer to the aircraft seat. Transfer to a seat with pivoting armrests was much easier as the subject could slide over in to the seat with help.	Considerable physical contact was required during transfer to the aircraft seat. Transfer to a seat with pivoting armrests required less lifting and the subject felt more comfortable.	Although the passenger could be seated in the front near the entrance, safety regulations do not allow a mobility-impaired passenger to sit near the entrance or exit. Boarding required an extreme amount of strength and body control on the part of agents to board passengers with dignity.	It would be extremely difficult to manoeuvre in the vestibule any person with body width exceeding the width of Columbia chair. Due to tight dimensions of vestibule, passenger body would come in close contact with bulkheads and walls.

Table 8-1: Results of Live Boarding Demonstrations (continued)

	DASH 8-100	REGIONAL JET	METROLINER	BEECHCRAFT 1900D
Overall accessibility for passengers using a mobility aid.	Good accessibility.	Good accessibility.	Marginal accessibility. Access possible only when a Just Mobility chair and a lifting device are used.	Limited accessibility. First row accessible with most chairs. Access to other rows possible only when a Just Mobility chair and a lifting device are used. Access also limited by the body size of the passenger.

As reported in Table 8-1, no obstacles to boarding were encountered in boarding exercises with the Dash 8-100 and CRJ. Disabled subjects who participated in these exercises could be boarded by trained carrier agents and according to the established procedure. The results of the demonstration showed that:

- Dash 8-100, Dash 8-300, and CRJ are easily accessible to passengers using a wheelchair.
- Access to rows two and up on both Dash 8 and CRJ is substantially easier than to the first row because seats beyond the first row have pivoting armrests. However, seats in the first row would be more comfortable for individuals with certain disabilities because they have extended leg room.
- Boarding can pose an inherent risk of injury to both passenger and carrier agents due to the amount of lifting required.
- Boarding involves a lot of physical contact between passenger and agents and may be considered unwelcome and undignified way of boarding an aircraft, particularly if the passenger is a female.

The table also reports that significant obstacles were encountered during boarding exercises with the Metroliner and Beechcraft 1900D, confirming the initial accessibility assessment from Section 5. The results of the demonstrations showed that:

- Both the Beechcraft 1900D and Metroliner have a very narrow aisle and a very tight vestibule.
- On the Metroliner, the aisle can be accessed only with the Just Mobility chair. On the Beechcraft 1900D, this chair is required to access rows two and up. Since the Just Mobility chair is not designed for carrying passengers up and down aircraft stairs, and since transferring from the Columbia/Washington chair to the Just Mobility chair in the aircraft vestibule is not possible, this implies that:
    - Metroliner is accessible only when a lifting device (which raises a passenger in a chair to the aircraft door) and a Just Mobility chair are used.
    - Beechcraft 1900D is accessible with the Columbia chair but only to the first row. Rows two and up can be accessed only with a Just

Mobility chair, which also requires the use of a lifting device. Moreover, access may be difficult and considered undignified to any person whose body width exceeds 30 cm (12 in).

- In the Metroliner, as the distance from the vestibule to the seat in the first row is very short, carrier agents were able to transfer the subject to this seat. However, due to the tight space, this procedure was very difficult for the agents and uncomfortable for the passenger.[15]

[15] In general, seating near the entrance is not allowed for passengers with a mobility impairment. In practice, passengers with a mobility impairment are allowed to be seated in the seat in the first row in the Metroliner as this is the only seat accessible with commonly used boarding chairs.

9: SUMMARY OF FINDINGS

This project identified boarding devices for passengers using a wheelchair and examined their availability and use in Canadian airports, their operational features and their compatibility with various small aircraft types, in particular with aircraft most commonly used in scheduled air services in Canada.

The methodology involved the following:

- Identification of boarding devices for small aircraft and collection of information on their availability and use in Canadian airports;
- Identification of boarding and transfer chairs and their evaluation in terms of compatibility with small aircraft, safety, ergonomic features, and ease of operation;
- Identification of small aircraft used in Canada, and in particular identification of fleet composition of the five largest carriers, and
- Detailed study of selected aircraft types, including analysis of passenger cabin layout, aircraft inspections, and live boarding demonstrations.

Seven aircraft types were selected for the detailed study:

- Dash 8-100;
- Dash 8-300;
- Canadian Regional Jet (CRJ);
- Beechcraft 1900D;
- Metroliner;
- HS 748; and
- ATR 42.

The above aircraft types account for over 77 percent of flight volume on small aircraft. Thus, the results of this study give a representative picture of accessibility of air travel to passengers using a mobility aid.

All aircraft types were inspected in person, and boarding demonstrations were performed on the Dash 8-100 (with the conclusions carrying over to the Dash 8-300), CRJ, Beechcraft 1900D, and Metroliner.

Below is a summary of study findings:

1. There is a wide range of boarding equipment for small aircraft with 19 to 60 passenger seats manufactured and available on the market. This equipment can be divided into four groups on the basis of their technical advancement:

   - Boarding chairs;
   - Mechanical lifts;
   - Ramps; and
   - Bridges (low-level boarding bridges).

   Boarding chairs represent least advanced equipment to board a passenger who uses a wheelchair, while bridges represent the most advanced equipment. Lifts, ramps, and bridges still require the use of a boarding or transfer chair to move the passenger from the aircraft door to the aircraft seat.

2. Each airport in the sample has at least one boarding chair; many have a mechanical lift, but none had the most advanced equipment such as a ramp or a low-level boarding bridge at the time when survey data were collected.[16]

3. The identified lifts, ramps and bridges are compatible with most types of small aircraft used in scheduled air service today. Some incompatibilities do exist. In particular, bridges are compatible only with some aircraft due the construction of many types of small aircraft and the operational constraints of the bridges. However, in all airports surveyed, all level change devices available in a particular airport are compatible with all aircraft types using that airport.

[16] At the time of writing this report, Kelowna International Airport was in the final stages of testing and adjusting its recently purchased low-level boarding bridge.

4. All boarding and transfer chairs identified in this project are compatible with the stairs and service doors of aircraft most commonly used in scheduled air service (i.e. Dash 8-100, Dash 8-300, Canadair Regional Jet, Beechcraft 1900D, Metroliner, HS 748, and ATR 42). However, not all chairs are compatible with the aisles of these aircraft. Only one type of transfer chair, the Just Mobility chair, is compatible with the Metroliner and Beechcraft 1900D. Another type of chair, the Columbia chair, can provide access to the first row in the Beechcraft. Several chair types are incompatible with the HS 748 and ATR 42.

5. Although there were no airports in the sample where all aircraft types served are incompatible with boarding equipment, 46.7 percent of airports serve an aircraft type for which there is no compatible combination of level change devices and boarding/transfer chairs in that airport. These incompatibilities are solely due to lack of boarding and transfer chairs compatible with all aircraft types, specifically aircraft aisles, served in the given airport.

6. Bridges are the most effective boarding devices in terms of passenger/staff safety, passenger dignity, and integration of boarding passengers with a disability and general boarding. On the other hand, boarding chairs are the least effective device and an unsatisfactory method of boarding passengers using a mobility aid on small aircraft. Mechanical lifts and ramps fall in between these two extremes.

7. Currently, air carriers are responsible for boarding passengers and are expected to provide boarding equipment. As more advanced technologies – mechanical lifts and bridges – are very expensive compared to the simplest technologies such as boarding chairs, the most advanced devices are likely not affordable to many air carriers for all destinations that they serve.

   In some airports, boarding equipment is owned by the airport authority. Thus, this and other alternative methods of financing remain an important area for exploration.

8. The Dash 8-100, Dash 8-300, and CRJ aircraft are easily accessible to passengers using a mobility aid. These aircraft types account for 60 percent of flight volume.

9. Access to the Beechcraft 1900D and Metroliner is limited or marginal, requiring the use of a lifting device and a Just Mobility chair. The

Beechcraft 1900D can also be accessed with the Columbia chair but only up to the first row. The two aircraft types account for about 16 percent of flight volume.

10. Accessibility of the HS 748 and ATR 42 is somewhat limited. Both aircraft types are compatible with the Just Mobility transfer chair and the Columbia boarding chair. However, the HS 748 is not compatible with the Washington chair, which tends to be used most often in Canadian airports. Moreover, the two aircraft types are incompatible with several other chair types used in the industry. The two aircraft types account for less than 2 percent of the total flight volume.

11. Although aircraft aisles may be accessible for a boarding chair, it may be difficult to board a passenger who has large waist and hip dimensions in a dignified way.

12. The physical transfer of a passenger from a wheelchair to a boarding chair and from the boarding chair to the aircraft seat still presents the biggest challenge for the agents as well as for the passenger, requiring strength, body control, lifting and passenger contact.

13. The transfer from a boarding chair to an aircraft seat with a pivoting armrest is definitely easier for the passenger and the carrier agent.

14. In several types of aircraft (Dash 8 series and CRJs) the first row of seats has more leg room and would therefore be more accommodating, but these seats have fixed armrests, which makes lifting the passenger over the armrest much more difficult.

15. The Columbia chair is one of the better designed chairs and is significantly better than the commonly used Washington chair. It has several ergonomic features that provide a relatively high level of comfort to the passenger as well as features that facilitate its operation by carrier agents.

10: CONCLUSIONS AND RECOMMENDATIONS

This study identified a wide range of boarding equipment for small aircraft, from low-tech boarding chairs, various types of lift devices and technically advanced low-level boarding bridges.

10.1 Conclusions

Bridges were evaluated as the most effective devices in terms of passenger/staff safety, passenger dignity, and integration with general boarding. Boarding chairs were evaluated as the least effective devices and as an unsatisfactory method of boarding.

Although all types of equipment provide safe access to aircraft, survey findings indicated a number of problems remaining even with the most technically advanced devices. Specifically, boarding chairs still have to be used with lifts and bridges as seats in aircraft can only be accessed using a narrow wheelchair such as a boarding chair. This also implies that accessibility of small aircraft to passengers with a mobility impairment in an airport is determined by the availability of both level change devices compatible with aircraft doors and boarding or transfer chairs compatible with small aircraft aisles.

Although each aircraft type has a compatible level change device and compatible boarding or transfer chair, not all Canadian airports have compatible combinations of these devices for all small aircraft types that they serve. As Table 6-3 shows, 46 percent of airports surveyed did not have a compatible combination of level change devices and boarding chairs for some aircraft types using the airport. The accessibility problems are entirely due to the lack of a versatile boarding chair compatible with narrowest aisles on small aircraft. As the manufacturer of a narrow chair type (the Just Mobility Chair) compatible with all small aircraft types could not be located, this implies that passengers with mobility impairments are likely to face difficulties in accessing aircraft now and in the near future.

More effective boarding devices are very expensive, and the majority of airports and air carriers cannot afford to purchase such equipment from their own funds. Alternative sources of funding should thus be investigated and promoted.

The relatively low survey return rate also suggested that a third party, a consulting firm, cannot exert enough pressure on the target populations of survey

respondents and to motivate them to participate in a survey and fill out a survey questionnaire. Faced with time constraints and rising costs, companies give a low priority to surveys or are outright unco-operative. A database resulting from a survey administered by a consultant will thus likely have several gaps, uncertain information, or inconsistencies. A bottom-line incentive, on the other hand, would certainly motivate a company to provide the required information.

In the case of the airline industry, such a bottom-line incentive can be relatively easily designed. One possibility is linking information on boarding equipment with other information in the OAG database. In other words, the OAG could collect information on available boarding devices and provide it to users together with other information such as aircraft type, flight number, days of operation, etc. Travel agents would be looking for information on available boarding devices (on behalf of persons with a disability making an inquiry) and sell an increasing number of tickets for destinations where a device is available. Competition between airlines and airports and competition from alternative modes of transportation would motivate air carriers to reveal the requested information and, in the long run, to improve their equipment.

Linking information on boarding devices with the OAG would thus create a truly dynamic database with a vast amount of information on boarding devices, including availability and type of compatible boarding devices (by airports, air carriers, etc.) and their operational characteristics. HLB demonstrated that such a database is feasible in its design.

The execution of this approach would involve no cost to the government, very little cost to the air carriers, and less than CAN$10,000 to the OAG. The resulting database could be used both at the policy level and the passenger level.

10.2 Recommendations

The following are recommended on the basis of the findings of the study. The first three recommendations are considered as the key recommendations of this study, and the remaining three recommendations are considered as the supporting recommendations.

RECOMMENDATION 1: *FULL PASSENGER INFORMATION TO FACILITATE PASSENGER CHOICE AND PROMOTE PROVIDER COMPETITION*

The experience of this study shows that a third party, such as a consulting firm, is unable to exert enough pressure on the target populations of companies to motivate them to participate in a survey, such as a survey of boarding devices, and fill out a detailed questionnaire. A database resulting from such a survey will likely have several gaps and inconsistencies.

Yet information on available boarding devices and boarding procedures must be public and available at the point where airline tickets are sold. Information about wheelchair boarding and stowage choices at the departure, arrival and connecting airports should be visible as part of routinely provided information in relation to every scheduled flight. This information should appear, again routinely, as part of every passenger's regular flight itinerary. Below is an example.

Air Mobius Flight 3035;
Leave Granola Intl. Airpt 0855; Dash 8; Snack; Columbia Chair
Arrive Canola Intl. Airpt 1019; Low-Level Loading Bridge, Just Mobility Chair

Linking information on boarding equipment with other information in the OAG database is one possible bottom-line incentive for air carriers to co-operate and provide the requested information. The OAG is a continuously updated database that provides the foundation for most information available to travel agents and internet booking sites. With virtually no additional penalty in cost or time, airlines and airports could supply wheelchair boarding and stowage information to the OAG along with the flight schedules and aircraft information they already supply on a regular basis. Travel agents could then provide passengers with up-to-date information about the boarding technology and wheelchair stowage choices on all flights available for the desired trip. Passengers could then select the choice that best serves their needs; competition to present the best choice would be fostered, to the extent feasible, among airlines accordingly.

In addition, a database of boarding devices and procedures created in this way will be a truly dynamic and comprehensive database with the potential of

extensive use at the policy level. The execution of this initiative would involve no cost to the government.

RECOMMENDATION 2: *AN INNOVATIVE FINANCING SOLUTION BASED ON PUBLIC-PRIVATE PARTNERSHIP MODEL TO ENSURE BOARDING LIFTS OR LOW-LEVEL BOARDING BRIDGES AT ALL AIRPORTS WHERE SUCH SOLUTION IS FEASIBLE*

This study has demonstrated that due to the tight space, access to the Beechcraft 1900D and Metroliner is limited or not possible using a typical boarding chair. For these aircraft, a lift and a very narrow Just Mobility transfer chair are necessary to board a passenger who uses a wheelchair.

This study has also shown that carrying the passenger up and down aircraft stairs is a challenging task for both the passenger as well as carrier agents. It requires significant strength on the part of agents and some body control on the part of passenger. The risk of injury to both passenger and agents is inherent in this procedure. For safety reasons, manual carrying of the passenger in chair should be avoided whenever possible.

Thus, low-level loading bridges, or appropriate boarding lifts in all airports, would ensure safer access to small aircraft.

However, since the air carriers are responsible for boarding and expected to provide boarding equipment, financing is likely to present a significant problem. Small air carriers may be unable to purchase with their own funds boarding lifts and bridges for all of their destination airports. Moreover, the market for provision of accessible air travel services is too small to promote – on the basis of demand/supply considerations – effective boarding equipment for those air carriers who could afford to purchase it.

Yet there is a "public good", or social benefit, in having an effective boarding device, such as the low-level boarding bridge, available in most airports. Economists call such situations a *market failure*. The solution to the market failure problem is the provision of the good or service by the government. In this case, the market failure provides a powerful justification for public-private co-financing of low-level boarding bridges. A business model should be developed immediately within which co-financing of at least one low-level boarding bridge at each Canadian airport can be negotiated among the relevant

parties, namely the federal and provincial government, the airline and the airport.

RECOMMENDATION 3: *PUBLIC-PRIVATE CO-OPERATION TO FINANCE AND STEER DEVELOPMENT OF ACCESSIBLE SMALL AIRCRAFT INTERIOR LAYOUTS*

Today, all types of small aircraft have a very small entrance vestibule and narrow aisles. A regular wheelchair cannot access these aircraft. It is thus necessary to use a narrow boarding or transfer chair in the boarding procedure. The results of live boarding demonstrations have shown that even access in a narrow chair can be difficult if not impossible. Therefore, improvements in the interior aircraft layout should be investigated. Ideally, the goal would be to re-design the cabin in such a way as to make a limited number of seats directly accessible from a regular wheelchair. At a minimum, aircraft should be easily accessible with all boarding chairs typically used in the industry.

Some options may exist in this area, and those that do not require a reduction in the total number of passenger seats aircraft type could be promoted as forward-going design recommendations. Research in non-aircraft vehicle domains (railway carriages and buses) indicates that accessible interior designs are feasible with virtually zero loss of regular passenger seating capacity (when no wheelchairs are on board). A jointly financed public-private research and development program should be launched with a view to extending such design concepts to the widest possible array of small aircraft in use for regular scheduled service.

RECOMMENDATION 4: *IMPROVEMENTS TO AIRCRAFT SEAT DESIGN IN ORDER TO MAKE THE ARMRESTS IN THE FIRST ROW MOVEABLE*

Although the armrests in rows two and up are moveable in the aircraft types examined, the armrests in the first row are not. (Typically, the armrest is used for storage of food trays.) Transfer of the passenger from boarding chair to aircraft seat over a fixed armrest is much more difficult than transfer to a seat with a moveable armrest. The first row also offers extended leg room and more space for manoeuvring the boarding chair, and does not require pushing the passenger in a boarding chair through the tight aircraft aisle. Therefore, whenever possible the seats in the first row should be used to accommodate passengers with a disability.

RECOMMENDATION 5: *STANDARDS FOR BOARDING CHAIR DESIGN THAT WOULD ADDRESS THE ERGONOMIC NEEDS OF PASSENGERS AND FACILITATE OPERATION BY CARRIER AGENTS*

At present, there are no standards for boarding chair designs, only guidelines developed by ATBLB in the United States over 10 years ago. Passengers who need boarding assistance often spend prolonged periods of time in a boarding or transfer chair. Ergonomic features that would ensure the comfort and safety of the passenger are thus essential. Moreover, a chair should have features that make it as easy as possible to operate for carrier agents, require minimum strength and involve minimum physical contact with the passenger during transport and transfers. The results of this study indicate that some chairs are better in these respects than others. Specifically, the Columbia chair is one of the better chairs and substantially better than the Washington chair. Thus, the less comfortable chairs should be phased out or improved.

RECOMMENDATION 6: *RESERVATION OF THE FIRST ROW FOR MOBILITY IMPAIRED PASSENGERS*

Boarding demonstrations carried out as part of this study showed that seating the passenger with mobility impairments in the first row is much easier than in rows two and up. The first row also has extended leg room that is required for the comfort of passengers with certain types of disabilities. At present, seating in the first row near the entrance is not allowed for passengers with mobility impairments due to safety regulations. However, seats in the first row opposite to the entrance door can be used to seat passengers with mobility impairments and could be reserved for this passenger group without regulatory changes.

RECOMMENDATION 7: *PUBLICLY FINANCED RESEARCH TO INVESTIGATE THE FEASIBILITY OF A BUILT-IN INTEGRATED BOARDING SYSTEM FOR SMALL AIRCRAFT TO BE USED IN SITUATIONS WHERE A LOW-LEVEL BOARDING BRIDGE IS NOT FEASIBLE*

Today, built-in lifts are available in many city buses and VIA Rail trains. A similar lift in airplanes would allow boarding of passengers with a disability in each and every airport where the particular airplane goes. This boarding mechanism would be more effective than a boarding chair and would make expensive mechanical lift devices unnecessary. Built-in lifts could thus be the

most economical solution to air carriers and ensure consistent boarding in every airport and by each air carrier.

RECOMMENDATION 8: *GUIDELINES FOR TRANSFERS AND OTHER DETAILS OF BOARDING PROCEDURE*

At the present time, there are no specific Canadian policies or guidelines for accessibility to small aircraft or the boarding procedure itself. Air carriers provide services consistent with the notion of non-discrimination on the basis of disability and avoiding the creation of undue obstacles to travel. A set of standards or guidelines would ensure consistent and dignified treatment of passengers by all air carriers and in each airport.

APPENDIX A: RELATIONAL DATABASE WITH INFORMATION ON SMALL AIRCRAFT AND BOARDING DEVICES

Challenges in the Development of a Relational Database with Information on Small Aircraft and Boarding Devices and Proposed Solutions

HLB developed the concept of a relational database with baseline information on small aircraft and boarding devices (small aircraft database). This database was intended to provide passengers and policy makers with extensive information on boarding devices across the airport, air carrier and small aircraft spectrum. A sample of the OAG database with flight records for aircraft with 19 to 60 seats provided information on small aircraft used in Canada. Survey instruments were designed in such a way as to obtain details of information on boarding devices, such as compatibility with small aircraft, price, operational characteristics, availability of various boarding devices in airports, boarding procedures used, etc.

However, a survey approach to populate such a database turned out to be an exercise facing a number of obstacles.

First, the relatively low survey return rate suggested that a third party, a consulting firm, cannot exert enough pressure on the target populations of survey respondents to motivate them to participate in a survey and fill out a survey questionnaire. Faced with time constraints and rising costs, companies give a low priority to surveys or are outright unco-operative. A database resulting from a survey administered by a consultant will thus likely have several gaps, uncertain information, or inconsistencies. A short survey would certainly generate a higher completion rate but the information collected would necessarily be very general in nature and thus have limited value for users, both passengers and policy makers.

Second, the use of surveys provides only a "snapshot" of the market where small aircraft operate. Changes to particular flight details, changes in the carrier makeup itself, and other unanticipated departures from the initial snapshot mean that results quickly become obsolete.

These limitations prompted HLB to consider an alternative approach. HLB proposes to link information on boarding equipment with other flight information in the OAG database. As we explain below, such a solution is both feasible and

cost-effective; it would involve no cost to the government and very little additional cost to air carriers and the OAG.

Airlines already submit flight-specific information to the OAG, and could be asked to submit boarding device/procedure details for each flight as well. Currently, the OAG contains 113 individual fields of information describing each flight. Carriers are thus accustomed to providing flight information and would face little additional expense in providing 2-4 additional fields of information such as departure device, arrival device, departure procedure, and arrival procedure. In addition, the carriers could be given the option to enter an "unknown" in these fields, and thus avoid any additional cost. However, travellers would be looking for such information when making their travel plans and purchasing a ticket, and thus competition between airlines/airports and from alternative modes of transportation would motivate air carriers to provide the requested information.

The proposed solution would create a truly dynamic database, updated regularly as new technologies become available, with flight-specific information. This database would meet its originally intended objectives in the following ways:

1. At the passenger level, a travel agent or passenger would have access to up-to-date flight information, including a list of boarding devices/procedures available at the departure and arrival airports, all at the touch of a button. To use this functionality, users would, through a travel agent or some other means, select a departure and arrival airport. The user would then be presented with a list of flights, times and carriers, each with an associated boarding device/procedure.

2. At the policy level, government officials would have access to flight-specific information. This information could then be aggregated to obtain data summaries by aircraft type, airport characteristic, boarding device type, boarding procedure, etc., and allow assessment of trends in the use of boarding devices and procedures.

In addition, in order to meet the needs of policymakers, HLB designed a relational database that would operate above the OAG database, creating a linking interface between OAG flight data, boarding device/procedure characteristics, aircraft characteristics, airport characteristics, carrier policies, contact information and other documentation. Policymakers would be able to

link and summarize this data so as to make informed decisions, and the data would remain current due to the dynamic nature of the OAG flight database foundation. The design of this database is presented in detail below.

Components of the Small Aircraft Relational Database

A relational database facilitates the analysis of data over and above the facility provided by a flat-table database or spreadsheet. A comparison of the two types of database reveals a number of tradeoffs between the two. Characteristics of the small aircraft database require the flexibility provided by a relational database, including an allowance for multiple values, updates, and the insertion and deletion of information.

Choosing a relational database design means creating a database that is most flexible in meeting the needs of the current project, as well as the needs of future analysts with different priorities, data, processing limitations, and hypotheses.

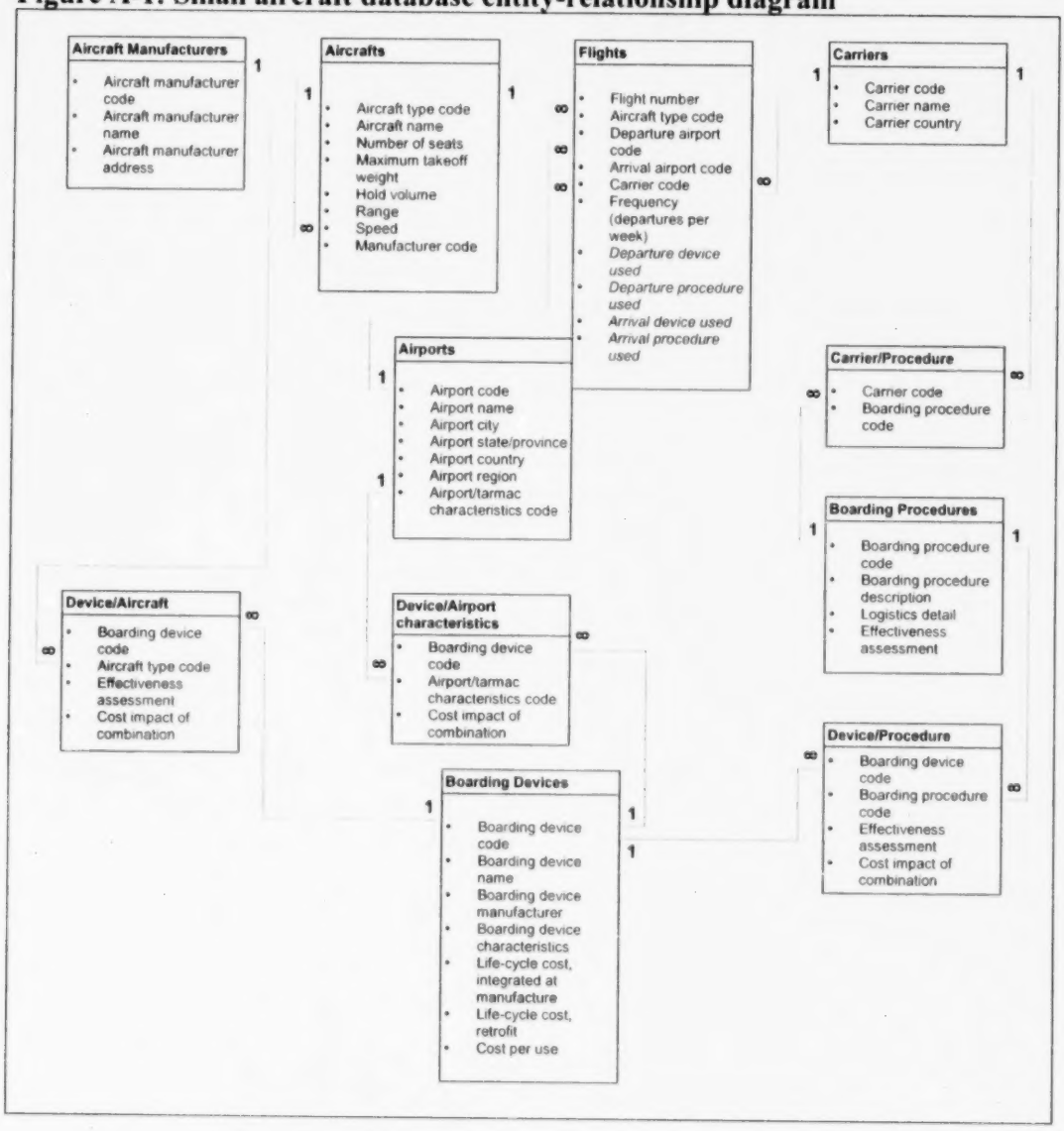
Figure A-1 provides a diagrammatic representation of entity relationships in the small aircraft database. Each rectangle in Figure A-1 represents a collection of information about certain types of objects, or entities. Entities in the small aircraft database include aircrafts, airports, carriers, boarding procedures and boarding devices. Each entity is associated with a number of properties, or attributes. These are listed in the rectangles in Figure A-1. Each entity with its associated attributes is called a table.

Figure A-1 also illustrates the relationships between the various entities. The inclusion of "1" and "∞" symbols in the diagram denote one-to-one and one-to-many relationships. Consider the following examples of these relationships:

- *One-too-many relationship* ($1-\infty$): Many flights are associated with one aircraft type and its characteristic information.
- *Many-too-many relationship* ($\infty-\infty$): Many boarding devices are associated with many aircraft types.

Notice in Figure A-1 that many-to-many relationships do not explicitly exist. To avoid the problems that these relationships create, intermediary tables are created (device/aircraft, device/procedure, carrier/procedure, and device/airport characteristics). These "convert" a many-to-many relationship into two one-to-many relationships.

Figure A-1: Small aircraft database entity-relationship diagram



Principal Output Exhibits

The relational small aircraft database is sufficiently flexible to allow the user to extract substantial amounts of data, and to organize this data in a number of ways. Preliminary results, however, focus on a number of principal output exhibits, and are easily accessible using pre-fabricated Microsoft Access forms.

Exhibit 1. Aircraft and route allocation database and look-up index

A form allows the user to enter a departure airport and/or an arrival airport. The database will then indicate the number of aircraft engaged in the requested flight, or in the case where a departure or arrival airport has been selected, the number of aircraft taking off or landing at that airport.

This exhibit uses the information in the flight, airport and aircraft tables.

Example Exhibit 1. Aircraft and route allocation database and look-up index

Move cursor to aircraft of interest.
Select F7 for seating and stowage capacity by wheelchair type
Select F8 for aircraft allocation by route and airport/class of terminal design
ATR-42: Seating 48, Cargo capacity for Powered []; Scooter []; _____[]
Beech 1900D, Seating 19, Cargo capacity for Powered []; Scooter []; _____[]
Bombardier Dash 8-100/200, 37 seats
Bombardier Dash 8-300, 50 seats
Bombardier Regional Jet, 50 seats
British Aerospace J.31, 19 seats
British Aerospace J.41, 30 seats
Convair 580, 30 seats
DeHavilland Dash 7, 50 seats
Dornier 328, 30 seats
Embraer EMB-120 Brasilia, 30 seats
Fokker 50 (F27-050), 50 seats
Fokker F27, 44 seats
Jetstream J-45, 19 seats
Metro III, 19 seats
Saab SF-340, 30 seats

Exhibit 2. Boarding device database and look-up index

There are three elements to this exhibit:

1. A form allows the user to navigate a list of boarding devices, and by selecting a device, cause a datasheet of device details to be presented, including the manufacturer address, capital and life-cycle cost details, engineering details, effectiveness assessments, compliance information, airport/tarmac requirements, conditions of liability, and other relevant information.
2. A user can navigate a list of aircraft types, and by selecting an aircraft type, be presented with a list of compatible boarding devices.
3. Finally, a user can select a series of airport/tarmac characteristics, and be presented with a list of compatible boarding devices.

This exhibit uses the boarding devices, device/aircraft, aircraft, device/airport characteristics, and airport tables.

Example Exhibit 2. Boarding device database and look-up index

Move cursor to device type *Select F6 for products by supplier.* *Select F7 for engineering detail, by product* *Select F8 for capital and life-cycle cost detail, by product* *Select F9 for aircraft compatibility/incompatibility analysis, by aircraft type* *Select F10 for effectiveness assessment and ranking, by aircraft* *Select F11 for compliance information regarding CAN/CGSB-189.1-95* *Select F12 for conditions of liability*
Lifting Device
Convertible stair/platform elevator (Germany) Enclosed cabin on back of truck (Australia, Germany) Forklift and pallet (Canada, UK) Galley service truck Inva lift (UK) Low level boarding bridge (DEW Engineering Ltd …) Motorized platform lift (Just Mobility, Wollard PAL-651 …) Stair climber (Mono climber, Stair aid; Switzerland, Norway) ….

Boarding Chair
Washington Chair
Manten Chair
Columbia Aisle Master
Sling
...

Exhibit 3. Boarding procedure database and look-up

A form allows the user to select from a list of boarding procedures/protocols. Each boarding procedure is itself associated with a number of device/aircraft independent characteristics. From this list, a summary of compatible boarding devices is produced. For each combination, an effectiveness assessment is displayed, and boarding devices can be ranked.

The small aircraft database can be expanded to allow for other relationships, such as the relationship between airport/tarmac conditions and boarding procedure, and between aircraft and boarding procedure.

This exhibit uses the carrier, carrier/procedure, boarding procedure, device/procedure and boarding device tables.

Exhibit 4. Compatibility and life-cycle cost analysis

Life-cycle cost (capital, maintenance and boarding time costs) analyses capabilities are provided for aircraft/boarding device/ boarding procedure combinations.

A form allows the user to select an aircraft, and asks that a series of airport characteristics be identified. The output is a table with compatible boarding device/boarding procedure combinations on the vertical axis, and life-cycle costs when integrated at manufacture and when retrofitted on the horizontal axis.

The exhibit uses the aircrafts, device/aircraft, boarding devices, device/airport characteristics, and device/procedure tables.

Exhibit 5. Compatibility and cost-per-passenger analysis

A form allows the user to select an aircraft, and asks that a series of airport characteristics be identified. With this information, the database lists compatible device/procedure combinations, and provides a breakdown of costs depending on the intensity of use.

The exhibit uses the aircraft, device/aircraft, boarding device, device/procedure, boarding procedure, device/airport, and airports tables.

Exhibit 6. Analysis of current practice vs. best practice

The small aircraft database is also able to include flight-specific numbers of passengers with disabilities, and device/procedure combinations used. With this data, a sixth and final exhibit is produced.

A form allows the user to select an aircraft, and asks that a series of airport characteristics be identified. With this information, the database can create a ranked list of device/procedure combinations best suited to the aircraft in question in a specific environment. With passenger and existing device/procedure usage data, the user is presented with a quick comparison of the best device/procedure solution, and the existing baseline.

The exhibit uses the aircraft, device/aircraft, boarding device, device/procedure, boarding procedure, device/airport, and airports tables.

APPENDIX B: RESULTS OF WORKSHOP WITH STAKEHOLDERS

Survey results reported in section 6 suggested that the vast majority of airports have some type of boarding device for small aircraft, at least a boarding chair, which allows passengers with mobility impairments to board the plane. This finding would suggest that accessibility of small aircraft to people with mobility impairments should not be a major problem that makes it impossible for people with disabilities to plan trips involving travel on small aircraft.

However, as indicated in section 5, boarding chairs can be considered a rather undesirable means of getting on board the airplane. They do not provide a high level of dignity to the passenger, and using them carries and inherent risk of injury to both the passenger and the agents operating the chair.

On the other hand, technically more advanced equipment is very expensive and most likely not affordable to many small air carriers and airports. In contrast, boarding chairs are inexpensive and affordable to each airline and airport and accomplish the task of moving the passenger to the door of aircraft.

These opposing considerations prompted HLB to consult with stakeholders, in particular with persons who use a wheelchair and frequently travel by air, and to ask the following questions:

- Question #1: Are there any conditions under which the boarding chair solution is acceptable?

- Question #2: If conditions for boarding chair technology are not satisfied, what factors should be considered in identifying the acceptable boarding technologies?

A Stakeholder Workshop on the project status and progress held at the Canadian Transportation Agency on November 2, 2000, provided a good opportunity and forum to raise these questions and solicit views and opinions from wheelchair users.

HLB encouraged stakeholders to express their thoughts and opinions based on their experience. About half of the stakeholders participating in the workshop felt that the boarding chair is an acceptable solution, in particular when taking into account the reality of high costs of alternative solutions. However, participants indicated that the design of the chairs is rather poor and staff training

unsatisfactory. Some of the comments made include those listed below. (The details are in Appendix F.)

- Boarding chairs are in general uncomfortable, in particular to individuals with a larger extent of injury/or disability.
- Boarding chairs "get the work done" but it is difficult for airline staff to operate them. Many airline employees seem to lack adequate training.
- Number of transfers between the passenger's own wheelchair and the seat on the plane may vary by wheelchair type. In the case of an electric chair, there may be up to four transfers. The number of these transfers should be minimized.
- Proper training of airline staff is important for the safety of the passenger as well as the airline employee and effectiveness of the equipment.
- Licensing standards should cover boarding.
- Co-operation by carriers with passengers and airport could improve boarding.
- There should be regulations as to where transfers are taking place.
- There should be some standards for boarding chairs. In particular, treatment with dignity of passengers should be emphasized.
- Boarding chairs should and could be improved. Research and development on the use of boarding chairs could provide input as to the possible improvements. Boarding chairs are simple and inexpensive, and one should recognize the reality that they will be used in the foreseeable future.

Some workshop participants indicated that boarding chairs might be acceptable at small airports. However, large airports should have a low-level boarding bridge suitable for small aircraft, or other higher technology solutions. These technologies are typically very expensive but the cost could be financed through airport fees. The feasibility of this solution was questioned, though, as large airports would require several such bridges, increasing total financing costs.

Some participants pointed out that in an ideal situation, boarding of passengers with a disability and able-bodied passengers should be integrated. This, however,

would most likely require special devices (such as a low-level boarding bridge or ramp), which are expensive.

APPENDIX C: MANUFACTURER QUESTIONNAIRE

HLB Decision Economics Inc.

Survey of Boarding Device Manufacturers

Please complete the following survey and return it to

HLB Decision Economics Inc.
99 Bank Street, Suite 400
Ottawa, Ontario
K1P 6B9

Alternatively, you may fax the completed survey to (613) 238-6096

Company Name	**Telephone Number**
Address	**Fax Number**
Contact Name	**Email Address**

1. **Listed below are several categories of boarding devices that can be used for passengers with mobility impairments to board small aircraft (19 to 60 seats). For each boarding device manufactured by your firm, please print the model name in the rectangle beside the appropriate device category.**

Device Category	Name of Model(s) Manufactured by Your Firm
A. Elevator/platform lift type	
B. Forklift/pallet/cabin type	
C. Galley service truck	
D. Stair climber	
E. Low level boarding bridge	
F. Other	

2. Please indicate in the following tables the specifications for each of the boarding device(s) you are manufacturing.

If this information is available in the form of marketing pamphlets or other literature, please send us this information and skip to question 3.

Device Specifications	**Model Name:**	**Model Name:**	**Model Name:**	**Model Name:** .....
Size when stored **L x W x H** *(m or feet)*				
Needs towing/pushing/pulling *(please specify)*				
Load capacity ***(lbs. or kg)***				
Lift platform size, L x W ***(m or feet)***				
Lifting height ***(m or feet)***				
Lifting mechanism motorized ***(Y / N)***	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐
Powered by: *(e.g. electric, propane, gas, other, please specify)*				
Manual back-up *(Y / N)*	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐
Manual operation *(e.g. crank, lever, pulley, other; please specify)*				
Safety features: *(e.g. brakes, lifting components, outriggers, other; please list all)*				

3. Please indicate the performance of your boarding device(s)

Performance Criteria	Model Name:	Model Name:	Model Name:	Model Name: .....
What types of wheelchairs can be lifted (e.g. manual, scooter, electric convertible, power, other; please list all)				
Time of equipment deployment incl. Preparation *(minutes)*				
Lifting speed of platform *(m/min or feet/min)*				
Slip resistant surface on platform *(Y/N)*	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐
Reliability of equipment in extreme temperature, *(please specify range. e.g. from -40 Celsius to +50 Celsius)*				
After sales back-up and assistance *(Y/N)*	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐
Parts delivery time *(days)*				
Product warranty *(please specify number of years for parts and labour)*				

4. Please indicate features which relate to passenger's safety and comfort, and to operator's qualifications

Safety and Operational Features	**Model Name:**	**Model Name:**	**Model Name:**	**Model Name:** .....
Safety features for wheelchair passengers on device *(e.g. handrails, front stop, rear stop, other; please specify)*				
Passenger protected against inclement weather *(Y / N)*	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐
How many persons are required to operate device *(specify number)*				
Physical effort(s) required by operator(s) of device *(e.g. lifting, pushing, pulling, cranking, other; please list and indicate lb/kg or torque)*				
Average training time required to operate device *(hours)*	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐

5. **A boarding protocol refers to the process of boarding or deplaning a passenger on to or off of an aircraft, e.g. location of wheelchair transfer, lifting of wheelchair passenger into own chair or carrier/airport chair, etc. If you recommend that your boarding device(s) be used according to certain protocols, please describe these in the chart below.**

Describe Recommended Boarding Protocol:	**Model Name:**	**Model Name:**	**Model Name:**	**Model Name:** .....

6. **In the following box, please summarize to what extent the devices manufactured by your firm comply with relevant codes and regulations in Canada, the US and other countries to which you export (e.g. ADA in US).**

7. **Please provide cost and maintenance information for the boarding device(s) that you manufacture**

	Model Name:	**Model Name:**	**Model Name:**	**Model Name:** .....
Suggested sales price *($)*				
Installation & implementation cost *($)*				
Estimated cost per inspection *($)*				
Other costs, *(please specify)*				
Recommended inspection(s) per year *(specify number of times)*				
After how many hours of operation do you recommend servicing device *(hours)*				
Average number of years before major overhaul *(number of years)*				

8. **Which of your boarding device(s) are compatible with the following small aircraft? Please ☑ compatible aircraft.**

Applicable aircraft	Model Name:	Model Name:	Model Name:	Model Name: .....
ATR - 48 seats	☐	☐	☐	☐
Bae (HS) 748 – 40 seats	☐	☐	☐	☐
Bae (HS) 748 – 42 seats	☐	☐	☐	☐
Bae Jetstream 31 – 19 seats	☐	☐	☐	☐
Beech 1900D – 19 seats	☐	☐	☐	☐
Boeing 727 – 100C / 100QC – 19 seats	☐	☐	☐	☐
Canadair Regional Jet – 50 seats	☐	☐	☐	☐
De Havilland DHC-6 Twin Otter – 19 seats	☐	☐	☐	☐
De Havilland DHC-6 Twin Otter – 37 seats	☐	☐	☐	☐
De Havilland DHC-8 Dash 8 Series 100 – 37 seats	☐	☐	☐	☐
De Havilland DHC-8 Dash 8 Series 300 – 50 seats	☐	☐	☐	☐
Douglas DC3 / C-47 Dakota – 27 seats	☐	☐	☐	☐
Embraer EMB – 120 Brasilia – 30 seats	☐	☐	☐	☐
Embraer RJ135/RJ145 – 50 seats	☐	☐	☐	☐
Fairchild Dornier 328 – 29 seats	☐	☐	☐	☐
Fairchild Dornier 328JET – 32 seats	☐	☐	☐	☐
Fairchild Metroliner – 19 seats	☐	☐	☐	☐
Fokker F28 Fellowship – 55 seats	☐	☐	☐	☐

8. Which of your boarding device(s) are compatible with the following small aircraft? Please ☑ compatible aircraft. (continued)

Applicable aircraft	Model Name:	Model Name:	Model Name:	Model Name: .....
Saab SF-340 – 30 seats	☐	☐	☐	☐
Saab SF-340 – 34 seats	☐	☐	☐	☐
Shorts 360 – 30 seats	☐	☐	☐	☐
Other, please specify:	☐	☐	☐	☐

9. Please describe the minimum requirements that airports and carriers must meet in order to use your equipment.

Airports

Technical

- Tarmac conditions (e.g. paved, gravel, grass, other; *please specify)*

- Storage facilities (e.g. covered, heated, other; *please specify*)

- Repair/maintenance facilities (e.g. shop with lift, heated, special tools, other; *please specify))*

- Other conditions (*please specify)*

Carriers

Technical

- Aircraft conditions (e.g. engines off, door open and secured, stairs deployed and secured, aircraft vestibule clear, other; *please specify)*

- Other

Any additional comments and/or documentation regarding your boarding devices that you are able to forward to us would be extremely valuable.

APPENDIX D: AIR CARRIER QUESTIONNAIRE

HLB Decision Economics Inc.

Survey of Canadian Air Carriers

Please complete the following survey and return it to

HLB Decision Economics Inc.
99 Bank Street, Suite 400
Ottawa, Ontario
K1P 6B9

Alternatively, you may fax the completed survey to (613) 238-6096

Airline Name and Airport Name	**Telephone Number**
Address	**Fax Number**
Contact Name	**Email Address**

1. **When boarding passengers who use mobility aids (e.g. wheelchairs, scooters, walkers) on small aircraft (aircraft with 19 to 60 seats), what boarding equipment do you have at your disposal? Please indicate the available equipment by checking (☑) the appropriate box in the list provided below.**

   If your firm does not have access to boarding equipment of this nature, please check this box and return the survey. ☐

Boarding chairs and on-board chairs *(please check applicable box ☑)*

Washington chair	☐
Manten chair (removable rear axle)	☐
E&J folding chair	☐
Columbia Aisle Master	☐
Wiltshire chair	☐
Seat case	☐
Nardin chair	☐
Canadian Aviation Equipment (CAE) chair	☐
Sling	☐

Other (*please specify*)
.....

Aircraft boarding devices (please check applicable box ☑ and specify make/ model).

Elevator/platform lift type	☐.....
Forklift/pallet/cabin	☐.....
Galley service truck	☐.....
Stairway climber	☐.....
Low level boarding bridge	☐.....
Other (*please specify)*	☐.....

2. **How many times a month do you deploy boarding equipment for passengers with mobility impairments?**

   ..... (*please specify the <u>minimum</u> and <u>maximum</u> number of times)*

If possible (and if you use more than one type of equipment), could you break down this information by equipment type and indicate it next to the appropriate item in Question 1, or in the space below?

.....

.....

3. **In the space provided, and for the boarding devices that you identified in Question 1, please indicate the aircraft types with which these boarding devices have been found to be compatible. As well, if you have experienced particular combinations of boarding devices and aircraft type that are incompatible, please indicate these below.**

.....

.....

.....

.....

.....

4. Who owns/leases the boarding equipment used by your firm? Please check the appropriate box (☑) in the table or describe in the space provided below the table.

Equipment Type	Carrier owned/leased	Airport owned/leased	Other arrangements *(please describe)*
Boarding chairs and on-board chairs	☐	☐	
Aircraft boarding devices	☐	☐	

Comments:.....

.....

5. If some of the equipment is owned jointly by your firm and the airport, could you please describe the cost sharing arrangements.

.....

.....

.....

6. Could you please provide the cost and operational information associated with each of the boarding chairs and on-board chairs used by your firm.

Cost and Operational Information	Washington chair	Manten chair	E&J chair	Columbia Aisle Master	Wiltshire chair	Seat Case	Nardin chair	CAE chair	Sling	Other (specify)
Purchase price (*Can $*)										
Number of staff required to prepare and perform / supervise one boarding operation (*specify #*)										
What is the average hourly wage of the staff performing these boarding operations? (*$ / hour*)										
Time it takes to <u>prepare</u> for one boarding procedure (*minutes*)										
Time it takes to <u>perform</u> one boarding procedure (*minutes*)										
Average cost of servicing device (in *$ per year*)										
Other costs (*please specify, $ per year*)										

Comments:.....

.....

7. Could you please provide the cost and operational information for the aircraft boarding devices used by your firm, <u>other than the chairs identified in Question 6</u>. Under "Model Name", indicate the specific device that you identified in Question 1.

Cost and Operational Information	Model Name:	Model Name:	Model Name:	Model Name: .....
Purchase price (*Can $*)				
Number of staff required for one boarding operation (*specify #*)				
What is the average hourly wage of the staff performing these boarding operations? (*$ / hour*)				
Time it takes to <u>prepare</u> for one boarding procedure (*minutes*)				
Time it takes to <u>perform</u> one boarding procedure (*minutes*)				
Average cost of servicing device (*$ per year*)				
Other costs (*please specify, $ per year)*				

Comments:

.....

8. **Please indicate which of the following boarding procedures you presently use when passengers who use mobility aids are boarding small aircraft.** *(please check applicable box* ☑)

If more than one procedure is used, please also indicate beside each box how often each procedure is selected *(for example, 50% of the time, 30% of the time).*

a) First in at departure, and last off at arrival ☐..... % of times selected

b) First in at departure, and first off at arrival ☐..... % of times selected

c) Last in at departure, and last off at arrival ☐..... % of times selected

d) Last in at departure, and first off at arrival ☐..... % of times selected

e) Other (*please specify*) ☐.....

9. **Do you keep specific seats reserved for passengers with disabilities on small aircraft?**

Yes ☐ **No** ☐

10. If you answered 'Yes', which seats and how many of them are being reserved for passengers with disabilities? Please specify in the following page table.

Seat Characteristic	Aircraft Type and # of seats
Extended Leg Room	
Behind Bulkhead	
With Movable Armrests	
Near Vestibule	
Other	

11. Could you please indicate which boarding protocols are used at your airport to board passengers with mobility impairments and with which boarding equipment and aircraft.

In the shaded text box, we provided the description of some typical protocols used to board passengers with mobility impairments, Departure Protocols 1, 2, and 3. If <u>your</u> protocol differs, please describe it below the table in the space provided.

If more than one protocol is used, could you also indicate how often the protocol is selected to board passengers with mobility impairments (*for example, 50% of the times, 30% of the times, etc.).*

Departure Protocol 1

- Wheelchair transfer in terminal (from own to narrow chair)
- Level change in narrow chair.
- Transfer from narrow chair to aircraft seat.

Departure Protocol 2

- Use of passenger's own chair from terminal to level change device.
- Level change in own chair.
- Wheelchair transfer in aircraft vestibule (from own to narrow chair).
- Transfer from narrow chair to aircraft seat

Departure Protocol 3

- Use of passenger's own chair from terminal to level change device.
- Level change in own chair.
- Transfer from own chair to aircraft seat

<u>Your Departure Protocol</u> (*please describe if different from Protocols 1, 2, and 3)*

.....

.....

.....

.....

Departure Protocols used (*please check)*	Boarding equipment used with this Protocol (*please specify)*	Small aircraft with which the Protocol and boarding equipment used (*please specify)*	% of times Protocol selected when boarding pax (*specify)*
Departure Protocol 1 ☐			
Departure Protocol 2 ☐			
Departure Protocol 3 ☐			
Other (*Please describe in the space provided below this table)*			

12. Could you please indicate which arrival protocols are used at your airport to deplane passengers with mobility impairments and with which boarding equipment and aircraft.

In the shaded text box, we provided the description of some typical protocols used to deplane passengers with mobility impairments, Arrival Protocols 1, 2, and 3. If <u>your</u> protocol differs, please describe it below the table in the space provided.

If more than one protocol is used, could you also indicate how often the protocol is selected to board passengers with mobility impairments (*for example, 50% of the times, 30% of the times, etc.).*

Arrival Protocol 1

- Transfer from aircraft seat to narrow chair
- Level change in narrow chair.
- Transfer from narrow chair to own chair in terminal

Arrival Protocol 2

- Transfer from aircraft seat to own chair
- Level change in own chair.
- Use of own chair to terminal

Arrival Protocol 3

- Transfer from aircraft seat to narrow chair
- Transfer from narrow chair to own chair in aircraft vestibule
- Level change in own wheelchair
- Use of own chair to terminal.

<u>Your Arrival Protocol</u> (*please describe if different from Protocols 1, 2, and 3)*

.....

.....

.....

.....

Arrival Protocols used (*please check)*	Boarding equipment used with this Protocol (*please specify)*	Small aircraft with which Protocol and boarding equipment used (*please specify)*	% of times Protocol selected when boarding pax *(specify)*
Arrival Protocol 1 ☐			
Arrival Protocol 2 ☐			
Arrival Protocol 3 ☐			
Other (*Please describe in the space provided below this table)*			

13. Could you please rate the boarding chairs and on-board chairs used by your firm?

For this purpose, use ratings on a scale from 1 to 3 where 1 stands for not satisfactory, and 3 stands for very good.

1: Not Satisfactory **2: Satisfactory** **3: Very Good**

Rating criteria	Washington chair	Manten chair	E&J chair	Columbia Aisle Master	Wiltshire chair	Seat Case	Nardin chair	CAE chair	Sling	Other (specify)
Technical performance of equipment										
Exposure to weather										
Integration with general boarding										
Passenger dignity: undue exposure to other passengers										
Passenger dignity: undue physical contact with staff (e.g. touching, carrying)										
Ease of set-up by staff, including preparation										
Ease of operation										
Maintenance and service required										
Staff safety for use of equipment										
Passenger safety for use of equipment										
Other factors, (*please specify*.....										

14. Could you please rate the performance of aircraft boarding devices used by your firm. Under "Model Name", indicate your specific device that you identified in Question 1.

For this purpose, use ratings on a scale from 1 to 3 where 1 stands for not satisfactory, and 3 stands for very good.

1: Not Satisfactory **2: Satisfactory** **3: Very Good**

Rating criteria	Model Name:	Model Name:	Model Name:	Model Name: .....
Technical Performance of equipment				
Exposure to weather				
Integration with the general boarding				
Passenger dignity: undue exposure to other passengers				
Passenger dignity: undue physical contact with staff (e.g. touching, carrying)				
Ease of equipment set-up by staff, including preparation				
Ease of equipment operation				

Maintenance and service required				
Staff safety for use of equipment				
Passenger safety for use of equipment				
Other factors (*please specify*)				

Comments:

.....

.....

15. Consider three general types of mobility aid (*Manual wheelchair folded, disassembled scooter and walker*), and estimate the number of each mobility aid that can be stored in the cargo compartment of the small aircraft you are using.

If this depends on the amount of other cargo (luggage, mail), please provide a range of estimates or an average based on a typical/average amount of other cargo.

For your reference, we provide the size of disassembled mobility aids in the shaded box below the table.

Aircraft type	Manual wheelchair	Powered wheelchair	Scooter	Walker
ATR - 48 seats				
BAe (HS) 748 – 40 seat				
BAe (HS) 748 – 42 seats				
BAe Jetstream 31 – 19 seats				
Beech 1900D - 19 seats				
Boeing 727-100C / 100QC – 19 seats				
Canadair Regional Jet – 50 seats				
De Havilland DHC-6 Twin Otter – 19 seats				
De Havilland DHC-6 Twin Otter – 37 seats				
De Havilland DHC-8 Dash 8 Series 100 – 37seats				
De Havilland DHC-8 Dash 8 Series 300 – 50 seats				
Douglas DC3 / C-47 Dakota – 27 seats				
Embraer EMB-120 Brasilia – 30 seats				

Embraer RJ135/RJ145 – 50 seats				
Fairchild Dornier 328 – 29 seats				
Fairchild Dornier 328JET – 32 seats				
Fairchild Metroliner – 19 Seats				
Fokker F28 Fellowship – 55 seats				
Saab SF-340 - 30 seats				
Saab SF-340 - 34 seats				
Shorts 360 – 30 seats				
Other, please specify:				
Other, please specify:				

Manual wheelchair folded: 106 cm x 94 cm x 30 cm/12 kg (42" x 37" x 12"/25 lb.)

Disassembled scooter: *Platform: 106* cm x 58 cm x 64 cm /15 kg (42" x 23" x 25"/32 lb.)
Rear end: 58 cm x 51 cm x 30 cm/25 kg (23" x 19" x 12"/55 lb.)
Seat assembly: 56 cm x 56 cm x 46 cm/16 kg (22" x 22" x 18"/35 lb.)
Batteries: 41 cm x 30 cm x 19 cm/19 kg (16" x 12" x 8"/42 lb.)

Walker: 92 cm x 51 cm x 35 cm /4.5 kg (36" x 19" x 14"/10 lb.)

APPENDIX E: AIRPORT QUESTIONNAIRE

HLB Decision Economics Inc.

Survey of Canadian Airports

HLB Decision Economics Inc.
99 Bank Street, Suite 400
Ottawa, Ontario
K1P 6B9

Alternatively, you may fax the completed survey to (613) 238-6096

Airport Name	**Telephone Number**
Address	**Fax Number**
Contact Name	**Email Address**

1. **When boarding passengers who use mobility aids (e.g. wheelchairs, scooters, walkers) on small aircraft (aircraft with 19 to 60 seats), what boarding equipment do you have at your disposal? Please indicate the available equipment by checking (☑) the appropriate box in the list provided below.**

   If your airport does not have access to boarding equipment of this nature, check this box and return the survey. ☐

   Boarding chairs and on-board chairs *(please check applicable box ☑)*

Washington chair	☐
Manten chair (removable rear axle)	☐
E&J folding chair	☐
Columbia Aisle Master	☐
Wiltshire chair	☐
Seat case	☐
Nardin chair	☐
Canadian Aviation Equipment (CAE) chair	☐
Sling	☐

   Other (*please specify*).

   Aircraft boarding devices (please check applicable box ☑ and specify make/ model).

Elevator/platform lift type	☐ .....
Forklift/pallet/cabin	☐.....
Galley service truck	☐.....
Stairway climber	☐.
Low level boarding bridge	☐.....
Other (*please specify*	☐.....

2. **How many times was the above boarding equipment used during the last four (4) weeks?**

   ..... (*please specify number of times)*

If possible (and if you use more than one type of equipment), could you break down this information by equipment type and indicate it next to the appropriate item in Question 1, or in the space below?

.....

.....

3. In the space provided, and for the boarding devices that you identified in Question 1, please indicate the aircraft types with which these boarding devices have been found to be compatible. As well, if you have experienced particular combinations of boarding devices and aircraft type that are incompatible, please indicate these below.

.....

.....

.....

.....

.....

4. Who owns/leases the boarding equipment available at your airport? Please check the appropriate box (☑) in the table or describe in the space provided below the table.

Equipment Type	Carrier owned/leased	Airport owned/leased	Other arrangements *(please describe)*
Boarding chairs and on-board chairs	☐	☐	
Aircraft boarding devices	☐	☐	

Comments:.....

.....

5. **If some of the equipment is owned jointly by air carriers and your airport, could you please describe the cost sharing arrangements.**

.....

.....

.....

6. Could you please provide the cost and operational information associated with each of the boarding chairs and on-board chairs available at your airport.

Cost and Operational Information	Washington chair	Manten chair	E&J chair	Columbia Aisle Master	Wiltshire chair	Seat Case	Nardin chair	CAE chair	Sling	Other (*specify*)
Purchase price (*Can $*)										
Number of staff required to prepare and perform / supervise one boarding operation (*specify #*)										
What is the average hourly wage of the staff performing these boarding operations? (*$ / hour*)										
Time it takes to <u>prepare</u> for one boarding procedure (*minutes*)										
Time it takes to <u>perform</u> one boarding procedure (*minutes*)										
Average cost of servicing device (in *$ per year*)										
Other costs (*please specify, $ per year*)										

Comments:

.....

7. **Could you please provide the cost and operational information for the aircraft boarding devices available at your airport, <u>other than the chairs identified in Question 6</u>. Under "Model Name", indicate the specific device that you identified in Question 1.**

Cost and Operational Information	Model Name:	Model Name:	Model Name:	Model Name: .....
Purchase price (*Can $*)				
Number of staff required for one boarding operation (*specify #*)				
What is the average hourly wage of the staff performing these boarding operations? (*$ / hour*)				
Time it takes to <u>prepare</u> for one boarding procedure (*minutes*)				
Time it takes to <u>perform</u> one boarding procedure (*minutes*)				
Average cost of servicing device (*$ per year*)				
Other costs (*please specify, $ per year*)				

Comments:

.....

8. Could you please indicate which boarding protocols are used at your airport to board passengers with mobility impairments and with which boarding equipment and aircraft.

In the shaded text box, we provided the description of some typical protocols used to board passengers with mobility impairments, Departure Protocols 1, 2, and 3. If <u>your</u> protocol differs, please describe it below the table in the space provided.

If more than one protocol is used, could you also indicate how often the protocol is selected to board passengers with mobility impairments (*for example, 50% of the times, 30% of the times, etc.).*

Departure Protocol 1

- Wheelchair transfer in terminal (from own to narrow chair)
- Level change in narrow chair.
- Transfer from narrow chair to aircraft seat.

Departure Protocol 2

- Use of passenger's own chair from terminal to level change device.
- Level change in own chair.
- Wheelchair transfer in aircraft vestibule (from own to narrow chair).
- Transfer from narrow chair to aircraft seat

Departure Protocol 3

- Use of passenger's own chair from terminal to level change device.
- Level change in own chair.
- Transfer from own chair to aircraft seat

<u>Your Departure Protocol</u> (*please describe if different from Protocols 1, 2, and 3)*

.....

.....

.....

.....

Departure Protocols used (*please check)*	Boarding equipment used with this Protocol (*please specify)*	Small aircraft with which the Protocol and boarding equipment used (*please specify)*	% of times Protocol selected when boarding pax (*specify)*
Departure Protocol 1 ☐			
Departure Protocol 2 ☐			
Departure Protocol 3 ☐			
Other (*Please describe in the space provided below this table)*			

9. Could you please indicate which arrival protocols are used at your airport to deplane passengers with mobility impairments and with which boarding equipment and aircraft.

In the shaded text box, we provided the description of some typical protocols used to deplane passengers with mobility impairments, Arrival Protocols 1, 2, and 3. If <u>your</u> protocol differs, please describe it below the table in the space provided.

If more than one protocol is used, could you also indicate how often the protocol is selected to board passengers with mobility impairments (*for example, 50% of the times, 30% of the times, etc.).*

Arrival Protocol 1 • Transfer from aircraft seat to narrow chair • Level change in narrow chair. • Transfer from narrow chair to own chair in terminal Arrival Protocol 2 • Transfer from aircraft seat to own chair • Level change in own chair. • Use of own chair to terminal Arrival Protocol 3 • Transfer from aircraft seat to narrow chair • Transfer from narrow chair to own chair in aircraft vestibule • Level change in own wheelchair • Use of own chair to terminal.

<u>Your Arrival Protocol</u> (*please describe if different from Protocols 1, 2, and 3)*

.....

.....

.....

.....

.....

.....

Arrival Protocols used (*please check)*	Boarding equipment used with this Protocol (*please specify)*	Small aircraft with which Protocol and boarding equipment used (*please specify)*	% of times Protocol selected when boarding pax *(specify)*
Arrival Protocol 1 ☐			
Arrival Protocol 2 ☐			
Arrival Protocol 3 ☐			
Other (*Please describe in the space provided below this table)*			

10. Could you please rate the boarding chairs and on-board chairs available at your airport?

For this purpose, use ratings on a scale from 1 to 3 where 1 stands for not satisfactory, and 3 stands for very good.

1: Not Satisfactory **2: Satisfactory** **3: Very Good**

Rating criteria	Washington chair	Manten chair	E&J chair	Columbia Aisle Master	Wiltshire chair	Seat Case	Nardin chair	CAE chair	Sling	Other (specify)
Technical performance of equipment										
Passenger dignity: undue exposure to other passengers										
Passenger dignity: physical contact with staff										
Ease of set-up by staff, including preparation										
Ease of operation										
Maintenance and service required										
Staff safety for use of equipment										
Passenger safety for use of equipment										
Other factors, (*please specify)*										

Comments:

.....

11. Could you please rate the performance of aircraft boarding devices available at your airport. Under "Model Name", indicate your specific device that you identified in Question 1.

For this purpose, use ratings on a scale from 1 to 3 where 1 stands for not satisfactory, and 3 stands for very good.

1: Not Satisfactory 2: Satisfactory 3: Very Good

Rating criteria	Model Name:	Model Name:	Model Name:	Model Name: .....
Technical Performance of equipment				
Passenger dignity: undue exposure to other passengers				
Passenger dignity: physical contact with staff				
Ease of equipment set-up by staff, including preparation				
Ease of equipment operation				
Maintenance and service required				
Staff safety for use of equipment				
Passenger safety for use of equipment				
Other factors (*please specify*)				

Comments:.....

.....

12. Please provide contact information for the air carrier staff at your airport responsible for boarding persons with disabilities onto small aircraft.

APPENDIX F: MINUTES FROM THE STAKEHOLDER WORKSHOP HELD ON NOVEMBER 2, 2000, AT THE CANADIAN TRANSPORTATION AGENCY

MINUTES FROM THE WORKSHOP WITH STAKEHOLDERS ON HLB SURVEY RESULTS REGARDING BOARDING SMALL AIRCRAFT

November 2, 2000

Canadian Transportation Agency

1. Introductions

2. Agenda and discussion questions posed by HLB

HLB presented briefly the agenda for the workshop and posed two discussion questions:

- Question #1: Are there any conditions under which the boarding chair solution is acceptable?

- Question #2: If conditions for boarding chair technology are not satisfied, what factors should be considered in identifying the acceptable boarding technologies?

The discussion questions were intended to solicit views and opinions from stakeholders, wheelchair users, on evaluation criteria of currently used boarding technologies, scope for improvements, and possible policy directions.

Before proceeding to the first item on the agenda HLB encouraged stakeholders to express their initial thoughts and opinions based on their experience. About half of the stakeholders participating in the workshop felt that the boarding chair is an acceptable solution, in particular when taking into account the high costs of alternative solutions such as higher technology devices. However, participants indicated that the design of the chairs is rather poor and staff training unsatisfactory. In particular the following comments were made:

- Boarding chairs are in general uncomfortable, e.g. they swing from side to side, have straight back, and require tilting when moving. These problems may be

particularly bothering for individuals with a larger extent of injury/ or disability, for example individuals with little stomach or back muscles.

- Boarding chairs get the work done but it is difficult for airline staff to operate them. Training is an important factor in this regard, and many airline employees seem to lack adequate training.

- Number of transfers between the passenger's own wheelchair and the seat on the plane may vary by wheelchair type. In the case of electric chair, there may be up to four transfers. The number of these transfers should be minimized, and the character and design of terminal chairs should also be taken into account.

3. HLB presentation of preliminary survey results

After a short discussion on discussion questions #1 and #2, HLB proceeded to the presentation of survey results on use of small aircraft and boarding devices in Canada. First, survey strategy was explained and the response rate reported.

Some participants pointed out that some large airports do not appear on the list of airports. HLB explained that this was due to lack of response from the airport in question. However, HLB emphasized that the results are based on a mix of large, medium, and small airports, which makes the results statistically valid.

Then HLB presented the results on the range of available boarding devices, compatibility with various aircraft and availability in airports. HLB emphasized that all airports in the survey had a boarding device. Specifically, all airports had a boarding chair and a large number of airports had a lifting device. Also, all aircraft types had a compatible boarding device.

A few corrections and editorial changes were suggested by the participants. In particular, it was pointed out that the DEW bridge and Turbo ramp still require mechanical lifting of the passenger to and from the narrow chair, and that two transfers are required to use the Stair Trac. The review of compatibility analysis would also be easier if boarding chairs were presented in one group and higher technology devices in another.

4. Discussion

After presentation of the preliminary survey results, HLB returned to the two discussion questions posed at the beginning of the workshop and asked for

comments in the context of evaluation criteria for boarding technology as well as boarding procedures. The following comments were made.

- Once again the need for proper training of airline staff was emphasized. This is important for safety of the passenger as well as the airline employee and effectiveness of the equipment.

- The equipment should be properly maintained.

- Bulkhead seats should be reserved/ designated for passengers with disabilities.

- Licensing standards should cover boarding.

- Cooperation by carriers with passengers and airport could improve boarding.

- There should be regulations as to where transfers are taking place.

- Number of transfers should be minimized

- There should be some standards for boarding chairs. In particular, dignified treating of passengers should be emphasized.

- Boarding chairs should and could be improved. R & D on the use of boarding chairs could provide input as to the possible improvements.

- Boarding chairs are simple and inexpensive, and one should recognize the reality that they will be used in the foreseeable future.

- Boarding chairs may be acceptable at small airports. However, large airports should have a low-level boarding bridge suitable for small aircraft or other higher technology solutions. These technologies are typically very expensive but the cost could be financed through airport fees. The feasibility of this solution was questioned, though, as large airports would require several such bridges.

- Some participants pointed out that in an ideal situation boarding of disabled and able-body passengers should be integrated. This, however, requires special devices (such as a low-level boarding bridge), which are expensive.

5. Conclusions and adjourn

6. Workshop participants

Discussants

Bob Brown, Lise Lecuyer, Nancy Ann Patten, Charles Sheppes, George Simpson

Observers

René Campeau, Diane Mainville, Hélène Nadeau, Barbara Smith

Consultants

David Lewis, Ewa Tomaszewska, Uwe Rutenberg

APPENDIX G: PHOTOGRAPHS OF TYPICAL BOARDING EQUIPMENT

Photo G.1: Typical Narrow Chair

Photo G.2: Typical Stair Climber

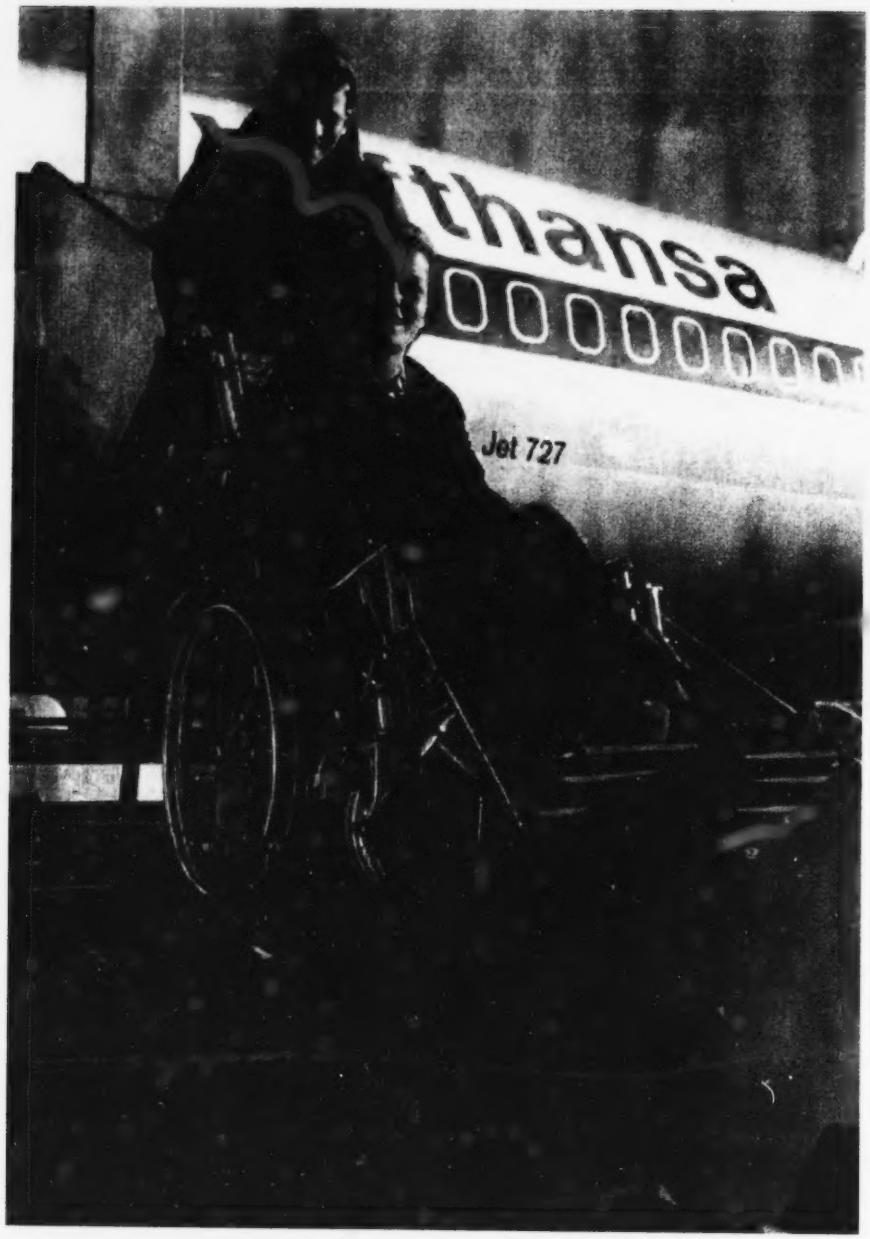


Photo G.3: Example of a Mechanical Lift

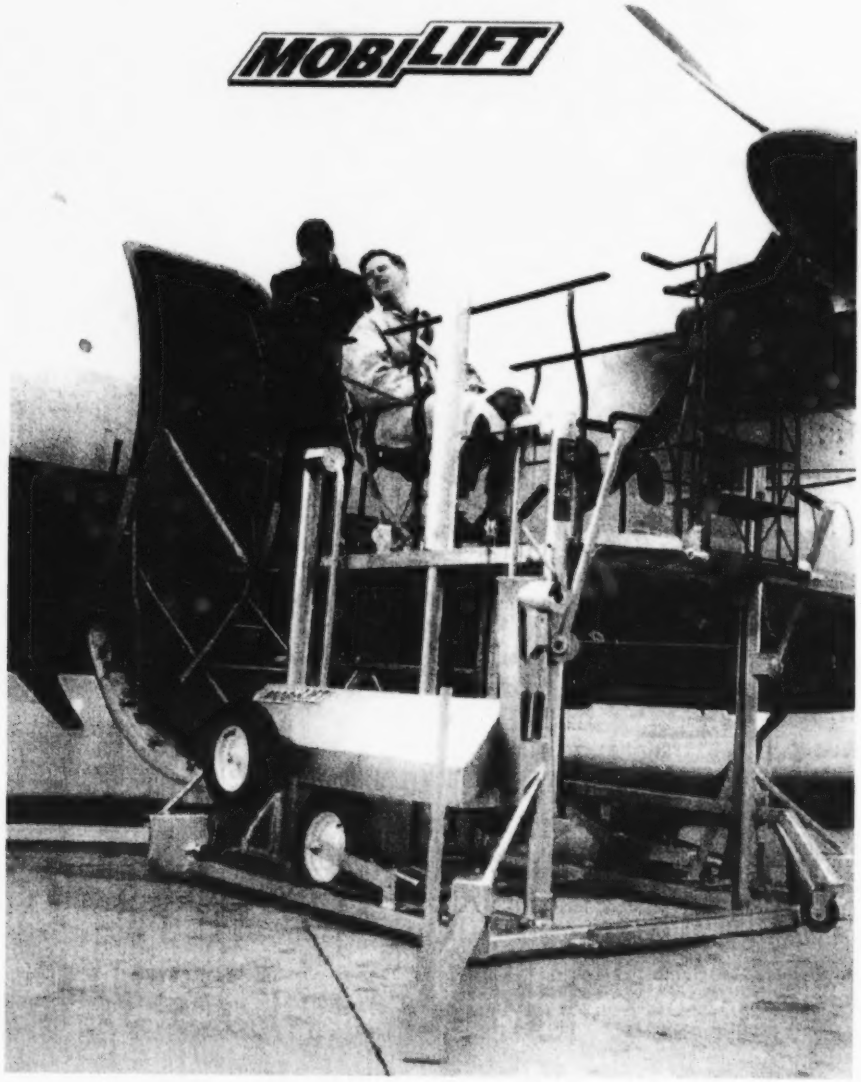
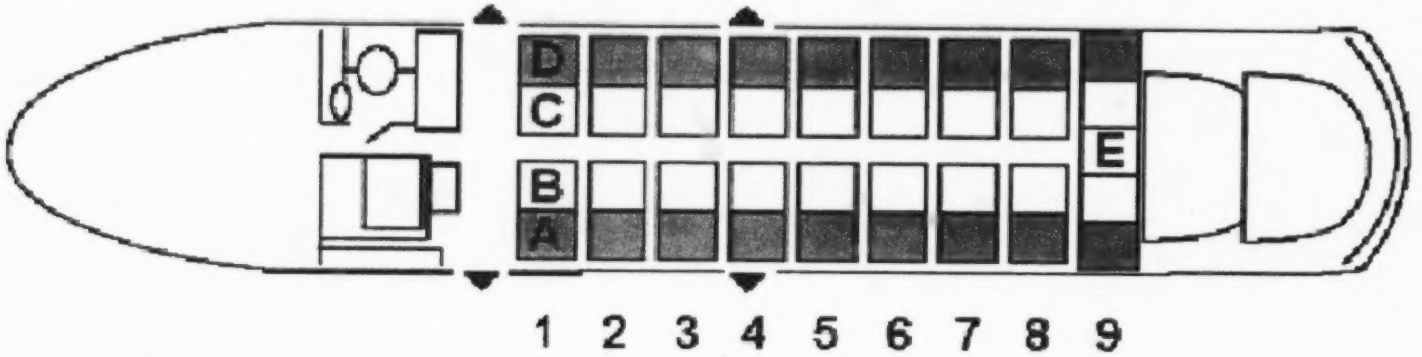


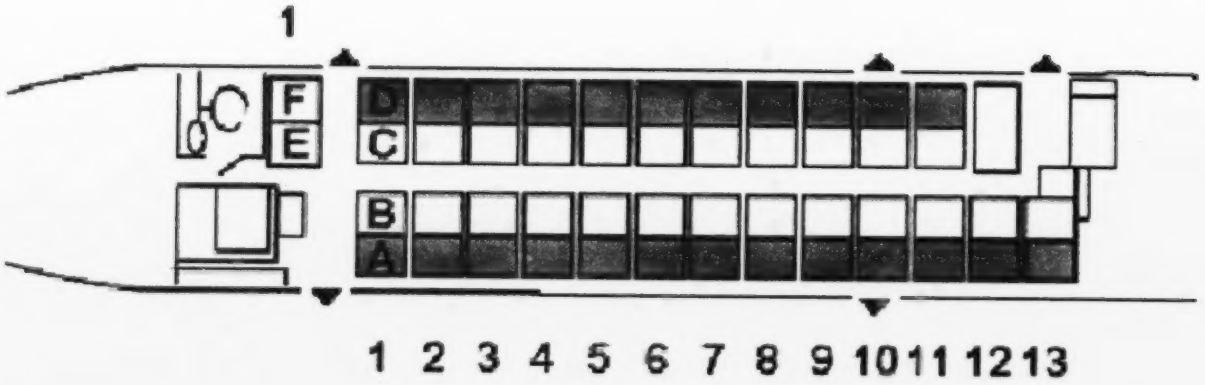
Photo G.4: Low-Level Boarding Bridge

De Havilland Dash 8-100



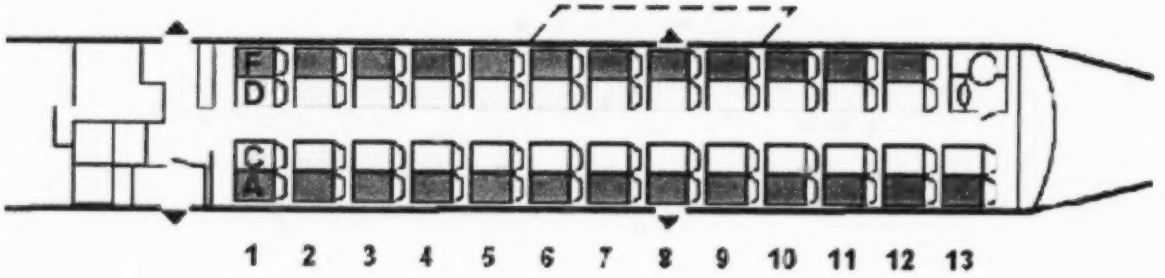
Number of seats:	36/37 seats + washroom
Aisle width:	15.5"/ 39.4 cm
Stair width:	22.5"/ 57 cm
Vestibule length:	52"/ 1.32 m
Vestibule width:	28"/ 71 cm
Vestibule height:	65"/ 1.65 m
Cargo door width:	50" / 1.27 m
Cargo door height:	59.5" / 1.51 m
Armrest fixed:	1 B + C
Armrest pivoting:	2-8 B + C

De Havilland Dash 8-300



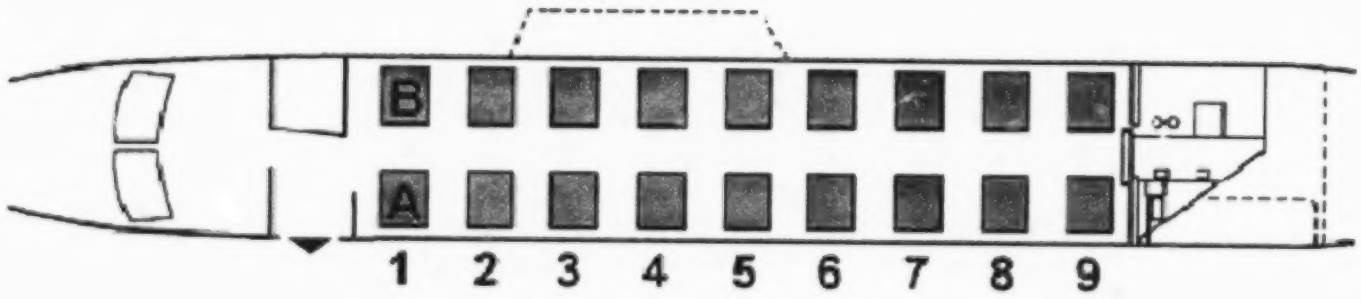
Number of seats:	48 seats + washroom
Aisle width:	15.5"/ 39.4 cm
Stair width:	22.5"/ 57 cm
Vestibule length:	52"/ 1.32 m
Vestibule width:	28"/ 71 cm
Vestibule height:	65"/ 1.65 m
Cargo door width:	50" / 1.27 m
Cargo door height:	59.5" / 1.51 m
Armrest fixed:	1 B + C
Armrest pivoting:	2- 11 B + C, and 12, 13 B

Canadair Regional Jet (CRJ)



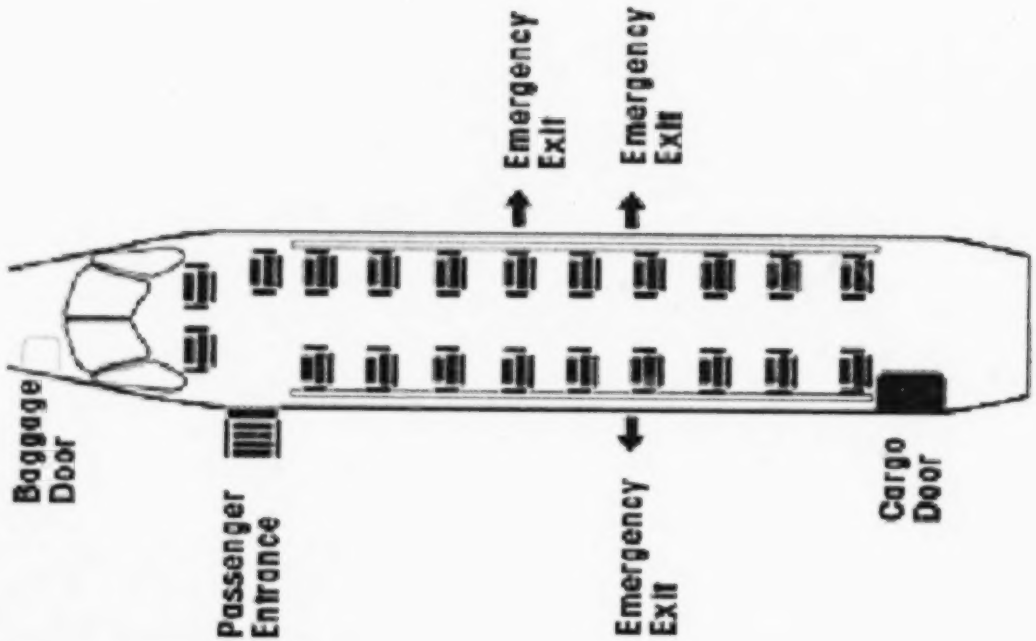
Number of seats:	50 seats + washroom
Aisle width:	16" / 40.6 cm
Stair width:	26" / 66 cm
Vestibule length:	45.5" / 1.15 m
Vestibule width:	39.5"/ 1.00 m
Vestibule height:	72" / 1.82 m
Cargo door width:	43" / 1.09 m
Cargo door height:	34" / 86.3 cm
Armrest fixed:	1 C + D
Armrest pivoting:	2 - 12 C + D, and 13 C

Beechcraft 1900D



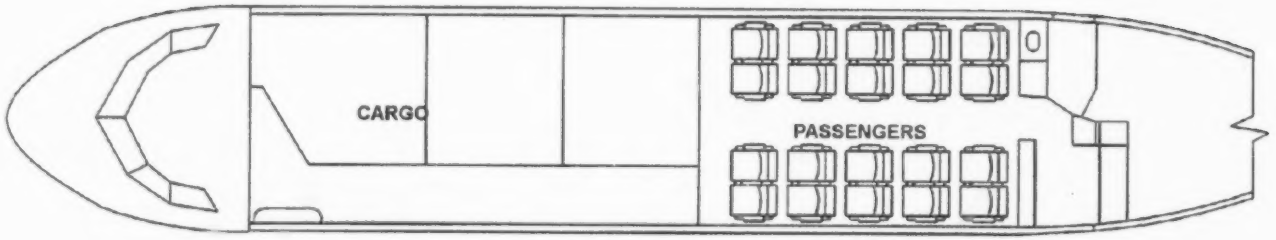
Number of seats:	18 seats + washroom, or 19 seats without washroom
Aisle width:	11 ¾" / 29.8 cm
Stair width:	19" / 48.3 cm
Vestibule length:	39" / 99 cm
Vestibule width:	40" / 101.6 m
Vestibule height:	70.5" / 1.79 m
Cargo door width:	56" / 1.42 m
Cargo door height:	57" / 1.44 m
Armrest fixed:	1 A + B
Armrest pivoting:	2- 9 A + B

Metroliner



Number of seats:	19 seats + washroom
Aisle width:	12.25" / 31.1 cm
Stair width:	23.5" / 59.7 cm
Vestibule length:	23" / 58.4 cm
Vestibule width:	22" / 55.8 cm
Vestibule height:	57" / 1.44 m
Cargo door width:	53" / 1.35 m
Cargo door height:	53" / 1.35 m

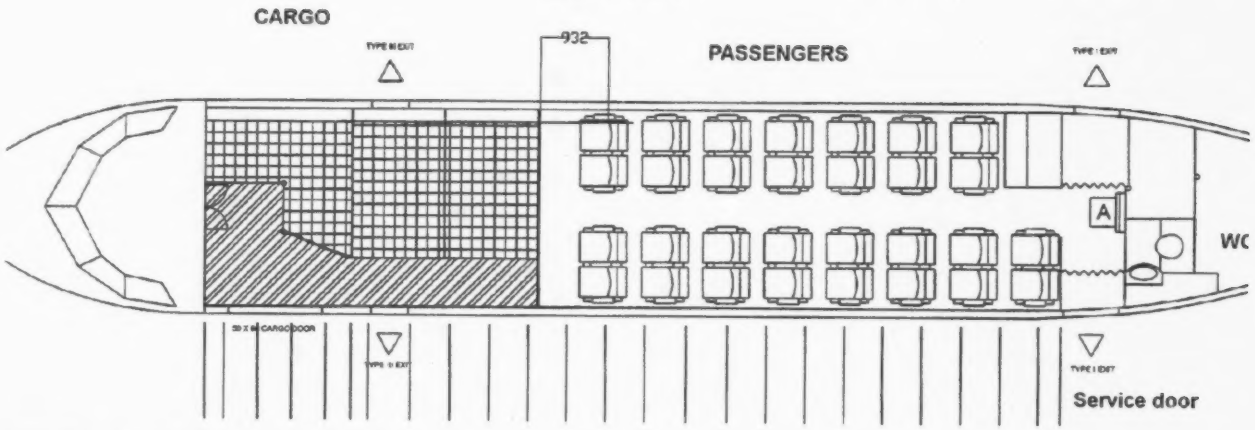
HS 748



Number of Seats:	20 seats + washroom
Aisle width:	14 ½" 36.8 cm
Stair width:	25"/ 63.5 cm
Vestibule length:	42" / 106.7 cm
Vestibule width:	38" / 96.5 cm
Vestibule height:	73" / 1.85 m
Cargo door width:	48"/ 1.22 m
Cargo door height:	53.5" / 1.36 m
Armrest fixed:	Unknown
Armrest pivoting:	Unknown

ATR 42

ATR42-300
30 PAX



Number of seats:	30 seats + washroom
Aisle width:	14 ½" 36.8 cm (to be verified)
Stair width:	21" / 53.3 cm
Vestibule length:	80" / 2.03 m
Vestibule width:	32"/ 81.3 cm
Vestibule height:	74.5" / 1.89 m
Cargo door width:	51" / 1.29 m
Cargo door height:	62.5" / 1.58 m
Armrest fixed:	Unknown
Armrest pivoting:	Unknown

APPENDIX I: DETAILED REPORTS FROM AIRCRAFT INSPECTIONS AND BOARDING DEMONSTRATIONS

This Appendix provides a detailed report of the on-site aircraft inspections and live boarding exercises with subjects using a mobility aid. The report is broken down by aircraft type examined.

Dash 8-100

- **Aircraft features**

The Dash 8-100 model, which was used for this demonstration was outfitted with 37 seats on a 2 + 2 layout with a bench of three seats across the rear.

The first row has fixed aisle armrests; the remaining six rows have pivoting armrests on their aisle seats. The aisle width is 15½" (39.4 cm) and would allow for the passage of the following boarding/on-board chairs:

1. Washington (37 cm)
2. Columbia (38 cm)
3. Manten (38 cm)
4. Seat Case (36.8 cm)
5. Wiltshire (35.5 cm)
6. E&J (38 cm)
7. Just Mobility (28 cm)

The stairs at the service door have a clearance of 22½" (57 cm), allowing the passage of all above mentioned boarding/on-board chairs.

The length of the vestibule (measured perpendicular to the fuselage's long axis) of 52" (1.32 m), a width of 28" (71 cm), and a height of 73½" (1.87 m) allow for one agent plus the boarding chair, and the ability to turn in to the aisle at 90 degrees. A passenger in a chair can be transported to any aisle seat from row 2 to row 6, which are equipped with a pivoting armrest, or can be transferred over a fixed armrest in row 1. The right side of row 1 has a generous leg clearance of 24" (61 cm); the left side aisle seat has even more leg room reaching into the vestibule.

The lavatory is not accessible for those who require a boarding chair to get to the washroom.

- **On-site inspection and demonstration**

The on-site demonstration saw a female subject using a power chair with a headrest and a table control. She has degenerative rheumatism, with very limited strength in her upper limbs and legs. She could stand up with some help but not walk. In the demonstration the Columbia chair was used.

The transfer from her chair to a Columbia chair took place on the tarmac near the aircraft, where the subject stood up with the help of one agent and transferred into the Columbia chair. She was carried up and down the stairs by two carrier agents who were trained in the procedure, one at the front, and the other at the rear of the chair. The weight of the subject plus the chair was approximately 140 lb (63.5 kg). The subject was carried head first into the vestibule, the agent at the rear then turning 90 degrees into the aisle and parking the chair parallel to the first row. The first transfer was carried out by lifting the subject over the fixed armrest of row 1 on the right side. One agent lifted from the rear of the chair, placing his arms under her shoulders and the subject placing her hands onto his wrists. The second agent put his arms under the subject's legs and both lifted simultaneously on the count of three. The transfer was carried out successfully and to the satisfaction of the subject, although considerable physical contact was required. The same procedure was reversed and another transfer carried out in a row where a pivoting armrest was available.

The transfer from the chair to the seat required much less lifting and the subject tried to slide over into the seat without help and almost succeeded. It must be noted that the Dash 8 models have seat backs that can be folded forward, which allows for more space for the agents to transfer the subject in and out of the seats.

Deboarding was carried out the same way, with the subject facing the front of the aircraft and being carried down the stairs legs first. No barriers for boarding or deboarding were encountered.

Measurements of the cargo door opening (50"/1.27 m wide and 59½"/ 1.51 m high) and inspection of the cargo area indicated that all common wheelchairs – manual, sports, power and scooters – can be accommodated without disassembling them, expect for the removal of batteries when necessary. Placing them on a conveyor belt carries out loading and unloading of the chairs.

- **Carrier policy**

It is the carrier's policy to board first and deboard last. This is necessary due to the tight spaces, which require the use of the complete space in the vestibule and around the seats that will be used.

- **Accessibility**

The demonstration of the Dash 8-100 model clearly indicated that this aircraft is accessible for persons who require the use of a boarding chair, can be transferred from their own chair, and can be accommodated within the width of an aisle of 39.4 cm.

Dash 8-300

According to the carrier the Dash 8-300 only differs from the 100 model in its length and the number of seats (50 instead of 37), therefore all other aspects that are mentioned for the 100 model would apply as well. It was therefore not deemed necessary to carry out a demonstration for the 300 model.

Canadair Regional Jet (CRJ)

- **Aircraft features**

The Canadair Regional Jet (CRJ) model has 50 seats on a 2 + 2 layout. The first row has fixed aisle armrests; the remaining rows have pivoting armrests on their aisle seats. The aisle width is 16" (40.6 cm) and would allow for the passage of the following boarding/on-board chairs:

1. Washington (37 cm)
2. Columbia (38 cm)
3. Manten (38 cm)
4. Seat Case (36.8 cm)
5. Wiltshire (35.5 cm)
6. E&J (38 cm)
7. Just Mobility (28 cm)

The stairs at the service door have a clearance of 26" (66 cm), allowing for the passage of all the above-mentioned boarding/on-board chairs.

The length of the vestibule (measured perpendicular to the fuselage's long axis) of 93" (2.36 m), a width of 39½" (1.00 m) and 22" (56 cm), and a height of 72" (1.83 m) allow for one agent plus the boarding chair, and to turn into the aisle at 90 degrees. A passenger in a chair can be transported to any aisle seat from row 2 and up, which are equipped with pivoting armrest, or can be transferred over a fixed armrest in row 1. The right and left sides of row 1 have a leg clearance of 18" (45.7 cm).

The lavatory is not accessible for those who require a boarding chair to get to the washroom.

- **On-site demonstration**

In the on-site demonstration a male subject who uses a sports chair volunteered. He is a paraplegic with limited strength in his upper body. In the demonstration the Washington chair was used. The transfer from his chair to the Washington chair took place in the terminal, where two agents transferred the subject. He was carried up and down the stairs by two carrier agents who were trained in the procedure, one at the front the other at the rear of the chair. The weight of the subject plus the chair was approximately 180 lb (82 kg). The subject was carried head first into the vestibule; the agent at the rear then turned 90 degrees into the aisle and parked the chair parallel to the first row. The first transfer was carried out by lifting the subject over the fixed armrest of row 1 on the right side. One agent lifted from the rear of the chair, placing his arms under the shoulder and the subject placing his hands onto his wrists. The second agent put his arms under the subject's legs and both lifted simultaneously on the count of three. The transfer was carried out successfully, although the subject experienced discomfort from being lifted from the back with the agent's arms under his arms. The same procedure was reversed and another transfer carried out in a row where pivoting armrests were available.

The transfer from the chair to the seat required much less lifting and the subject felt more comfortable, although positioning into the seat required further lifting from the agent at the rear. It must be noted that the CRJ models have seat backs that can be folded partially to the front, which allows for a little more space for the agents to transfer the subject in and out of the seats.

Deboarding was carried out in the same manner, with the subject facing the front of the aircraft and being carried down the stairs legs first. No barriers for boarding or deboarding were encountered.

Measurements of the cargo door opening (43"/1.09 m wide, and 34"/ 86 cm high) and inspection of the cargo area indicated that all common wheelchairs – manual, sports, power and scooters – can be accommodated, but those which are higher then 34" (86 cm) must be tilted to fit through the door height. Placing them on a conveyor belt carries out loading and unloading of the chairs. Caution must be exercised because the left jet engine is mounted close to the door.

- **Carrier policy**

It is the carrier's policy to board first and deboard last. This is necessary due to the tight spaces, which require the use of the complete space in the vestibule and around the seats that will be used.

- **Accessibility**

The demonstration of the CRJ model clearly indicated that this aircraft is accessible for persons who require the use of a boarding chair, can be transferred from their own chair, and can be accommodated within the width of an aisle of 40.6 cm.

Metroliner

- **Aircraft features**

The Metroliner Fairchild model has 19 seats on a 1 + 1 layout. The seats are mounted on each side on an elevated floor. The first seat on the right is directly opposite the service door, thus reducing the space to position an agent and the boarding chair. All seats have pivoting armrests. The aisle width is 12¼" (31 cm) and would allow only for the passage of the Just Mobility (28 cm) boarding chair. The Metro model has an extremely narrow fuselage with a vestibule length of only 23" (58.4 cm) and a standing height in the center of 57" (1.44 m).

The stairs at the service door have a clearance of 23½" (59.7 cm), allowing the passage of all major boarding/on-board chairs.

The length of the vestibule (measured perpendicular to the fuselage's long axis) of 23" (58.4 cm), a width of 22" (56 cm) and a height of 57" (1.44 m) do not allow for one agent plus the boarding chair to be positioned, nor to turn into the aisle at

90 degrees. A passenger in a chair cannot be transported to any aisle seat from row 2 and up, which are equipped with pivoting armrests.

- **On-site demonstration**

In the on-site demonstration a male subject who uses a power chair volunteered. He is a paraplegic with limited strength in his upper body. In the demonstration the Columbia chair was used; there was no boarding chair available that would pass through the aisle. The transfer from his chair to a Columbia chair took place in the terminal, where two agents transferred the subject. He was carried up and down the stairs by two contractor agents who were trained in the procedure, one at the front the other at the rear of the chair. The weight of the subject plus the chair was approximately 250 lb (113.5 kg). The subject was carried head first into the vestibule; the agent at the rear was unable to turn 90 degrees into the aisle. After many attempts the subject was eventually lifted into the front seat on the left side near the entrance. Safety regulations do not allow a mobility-impaired passenger to sit near the entrance/exit.

The transfer cannot be considered as being successful because of the dimensional limitations of the aircraft model. The subject did not always feel safe during this procedure.

Deboarding was carried out the same way, with the subject facing the front of the aircraft and being carried down the stairs legs first. The most serious barriers encountered were the tight dimensions preventing the agent the ability to turn, and for the agents to position themselves safely to manoeuvre the chair.

Measurements of the cargo door opening (53"/1.34 m wide, and 53"/ 1.34 m high) and inspection of the cargo area indicated that all common wheelchairs – manual, sports, power and scooters – could be accommodated without being disassembled. Manual or mechanical lifting carries out loading and unloading of the chairs.

- **Carrier policy**

It is the carrier's policy to board first and deboard last. The carrier indicated that mobility impaired passengers have been transported in this aircraft and seated in the first seat on the left-hand side near the entrance.

- **Accessibility**

The demonstration of the Metroliner model clearly indicated that this aircraft is only marginally accessible for persons who require the use of a boarding chair, can be transferred from their own chair, and can be accommodated within the limits of the vestibule. It requires an extreme amount of strength and body contortions on the part of the agents to board a passenger with dignity.

HS 748

- **Aircraft features**

NOTE: The HS 748 model could only be inspected at the maintenance centre of the carrier. It was not outfitted with seats and a demonstration was not possible due to the lack of installed equipment and facilities. The following indications and comments are based on measurements taken and information provided by the carrier.

The carrier for the transportation of cargo mainly uses this aircraft model; the layout is therefore divided about 50% freight and 50% for passengers. The seat layout can vary from 20 to 44 seats.

The service door opening, located at the rear left, is 31" (78.7 cm) in width and 62" (1.57 m) in height, with a stair clearance width of 25" (63.5 cm), and would accommodate all of the following boarding and on-board chairs:

1. Washington (37 cm)
2. Columbia (38 cm)
3. Manten (38 cm)
4. Seat Case (36.8 cm)
5. Wiltshire (35.5 cm)
6. E&J (38 cm)
7. Just Mobility (28 cm)

The dimensions of the vestibule (38"/96.5 cm wide, 42"/106.5 m long, and 73"/1.85 m high) would indicate that two agents carrying a chair could position themselves and turn the chair 90 degrees into the aisle using the washroom door opening to back in.

The aisle width of 14½" (36.8 cm) would allow passage of the Wiltshire and Just Mobility boarding chairs. The Seat Case and the Washington chair may possibly fit.

The carrier indicated that some of the aisle seats have pivoting armrests, but could not specify which.

The cargo door measurements of 48" (1.22 m) width and 53 ½" (1.36 m) height indicate that all common wheelchairs and scooters can be accommodated without disassembly, except for the removal of batteries where required.

The lavatory is not accessible for those who require a boarding chair to get to the washroom.

- **Comments**

The measurements and carrier comments of the HS 748 model seem to indicate that this aircraft is accessible for persons who require the use of a boarding chair, can be transferred from their own chair, and can be accommodated within the limits of the aisle.

- **Carrier policy**

It is the carrier's policy to board first and deboard last. This is necessary due to the tight spaces, which require the use of the complete space in the vestibule and around the seats that will be used.

ATR 42

NOTE: Although currently not listed as one of the most used small aircraft, one carrier indicated that it is now purchasing 12 of these models. It was therefore felt adequate to mention this aircraft and its features. Unfortunately the model was also only available in a stripped-down version in a hangar for maintenance so that a demo could not be carried out. Measurements were taken and comments provided by the carrier.

- **Aircraft features**

The number of seats on this aircraft can vary from 16 to 44, depending on the layout for cargo and passenger requirements. The service door is located at the rear section on the left side. The width of the door is 29" (73.6 cm), with a height

of 70" (177.8 m). The stair width is 21" (53.3 cm). This would indicate that the following boarding/on-board chairs could be carried up and through the door:

1. Washington (37 cm)
2. Columbia (38 cm)
3. Manten (38 cm)
4. Seat Case (36.8 cm)
5. Wiltshire (35.5 cm)
6. E&J (38 cm)
7. Just Mobility (28 cm)

The vestibule area measures 80" (2.03 m) in length, with a width of 32" (81.3 cm) and a standing height of 74½" (1.89 m). This indicates that two agents could comfortably carry a chair into the vestibule and turn 90 degrees in to the aisle. The aisle width is 15" (38 cm), which would allow passage for all the above boarding/on-board chairs, except the E&J, Manten and Columbia chairs.

The most accessible seat seems to be the last aisle seat left side, where the aisle dimension is about 2" (5 cm) wider and would accommodate the E&J, Manten and Columbia chairs.

The cargo door dimensions are 51" (129.5 m) wide and 62½" (158.7 m) high. This seems to easily accommodate all common wheelchairs and scooters without dismantling them, except for battery removal where required.

- **Accessibility**

This aircraft can be considered accessible for a passenger who can be transferred from his/her own chair to a boarding chair.

BEECHCRAFT 1900D

- **Aircraft features**

The Beechcraft 1900 model used for this demonstration was outfitted with 18 seats plus a washroom. The same model is available with 19 seats and no washroom. The seat layout is 1 + 1 (one seat each side). All seats have pivoting armrests. The aisle width is 11¾" (29.8 cm) and would allow only the Just Mobility chair to pass.

In the demonstration a Columbia chair was used with a seat width of 13" (33 cm), but could only be accommodated in the first row with both armrests in the up position. The stairs at the service door have a clearance of 19" (48.3 cm), allowing the passage of the following chairs to be carried up and down:

1. Washington (37 cm)
2. Columbia (38 cm)
3. Manten (38 cm)
4. Seat Case (36.8 cm)
5. Wiltshire (35.5 cm)
6. E&J (38 cm)
7. Just Mobility (28 cm)

The length of the vestibule (measured perpendicular to the long axis of the fuselage) of 39" (99 cm) and the distance to the first row make it very difficult for the agent at the back of the chair to turn 90 degrees into the aisle. A passenger in a boarding chair could only fit in the aisle if the Just Mobility chair is used and the passenger's body width does not exceed 12" (30 cm). For other boarding chairs only the first seat on the right side can be used. According to air safety regulations the one on the left side cannot be used because it is the closest to the exit.

- **On-site demonstration**

For the on-site demonstration a carrier agent volunteered to take the place of a disabled passenger. The transfer from a manual wheelchair to the Columbia chair took place on the tarmac near the aircraft. Two trained carrier agents transferred the subject from the manual chair to the Columbia chair, one from the rear (placing his arms under the subject's arms), and the other from the front (putting his arms under the subject's legs), and lifting simultaneously. The weight of the subject plus the chair was approximately 200 lb (91 kg). The subject was secured with lap, shoulder and leg belts. The subject was then carried up backwards with one agent at the rear of the Columbia chair and the other at the front, each using the horizontally extendable handlebars of the chair. Once in the vestibule, the agents had to pivot and slide the extended handlebars back into their folded position to reduce the overall length of the chair from 48" (1.22 m) to 30" (76 cm) in order to make the 90 degree turn into the aisle. The subject's body width did not exceed the width of the Columbia chair. It would be extremely difficult to manoeuvre any person exceeding this dimension because of the tight dimensions in the vestibule. By lifting both front seat armrests and the Columbia armrests, the chair could be moved into the aisle between the first seat rows but would not fit in

the rest of the aisle. The seat's armrests in the up position would prevent the Columbia chair from moving further.

The two carrier agents carried out the transfer from the chair to the seat, one from the front and the other from the rear, successfully with the seat armrests in the up position. The agent at the front had difficulties lifting the legs due to the tight dimension between the seat and the bulkhead (13"/33 cm). The procedure was reversed for deboarding, and before descending the stairs the agents extended the handlebars of the chair.

If a narrower boarding chair could be used to traverse the aisle and access other seats, the transfer would be facilitated by the fact that the seat backs can fold to the front by almost 90 degrees, making room for the agent in the front for the transfer.

Measurements of the cargo door and inspection of the cargo space indicated that all common wheelchairs – manual, sports, power and scooter – can be accommodated without disassembling them, except for the removal of batteries when necessary.

- **Accessibility**

This aircraft can only be considered accessible under certain conditions:

1. When boarding chairs with a width of over 30 cm are used, only the first seat on the right side is accessible.
2. When a boarding chair with a width less then 30 cm is used, the remaining seats are accessible.
3. If a person's body width exceeds 30 cm, vestibule dimensions may prevent dignified and safe access without the rest of the body coming in contact with bulkheads and walls.

- **Carrier policy**

It is the carrier's policy to board first and deboard last. At Dorval airport typically the PAL lift is used for boarding small aircraft for the Dash 8 series and the RJs. The lift is not used for the Beechcraft 1900 series because it would come too close to the propellers.

General comments applying to the boarding of all aircraft

Several aspects of concern should be mentioned:

1. Although many airports already have mechanical lifting equipment to board a passenger in a chair, several medium and small airports may still rely on the need to carry a passenger up and down the stairs. This in itself can present a safety problem for the agents and the passenger, especially in inclement weather when stairs are slippery or wet. The use of mechanical lift equipment would definitely improve this aspect.
2. The transfer from the passenger's own chair to the boarding chair and to the aircraft seat requires a great amount of close physical contact between an agent and the passenger. Improvements should be sought in this area to solve this problem.
3. The best available seat for a passenger who must be transferred from a chair to a seat is typically the front row, because of extended leg room and space, which makes the transfer easier for the agents and the passenger. The problem is that the front rows have fixed armrests due to the storage and use of trays, which makes the transfer over an armrest much more difficult for the passenger and the agent, especially when the passenger is very heavy. A solution should be sought to have pivoting armrests in the front rows as well.